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INDO-PACIFIC FISHERY COMMISSION (IPFC)

REPORT

of the

THIRD SESSION OF THE

STANDING COMMITTEE ON RESOURCES RESEARCH AND DEVELOPMENT

Sydney, Australia, 28 April - 4 May 1982

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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PREPARATION OF THIS REPORT

This is the final version of the report as approved by the third session of the IPFC Standing Committee on Resources Research and Development.

Distribution

Participants in the session
Members of the Commission
Other interested nations and
international organizations
FAO Fisheries Department
Fishery Officers in FAO Regional Offices

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ABSTRACT

The third session of SCORRAD discussed four main subjects: new approaches to resource assessment in tropical waters; the resources of squids and other cephalopods; shrimp fisheries, and training. These were discussed on the basis of working notes prepared by the Secretariat, and, for the fist two items, background papers prepared by most of the individual member countries describing their experience. These papers are included as annexes to the present report.

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OPENING OF THE SESSION AND ADOPTION OF THE AGENDA

1. The third session of the Standing Committee on Resources Research and Development (SCORRAD) was held at the New Crest Hotel, Sydney, N.S.W., Australia, from 28 April to 4 May 1982. The meeting was attended by scientific representatives from eleven member countries, and observers from Papua New Guinea and three international organizations. A list of those attending is given in Appendix 1. The session was opened by the Chairman, Mr G.D. Waugh, and the participants were welcomed by the Hon. P.J. Nixon, M.P., Minister for Primary Industry, on behalf of the Australian Government, and by Dr A. Lindquist on behalf of FAO. In thanking the Australian Government for their hospitality, Dr Lindquist gratefully noted the support provided for the attendance of some of the overseas participants. The agenda, as given in Appendix 2, was adopted.

2. The Chairman reviewed briefly the progress that had been made by the Committee during its relatively short life. He stressed the vital importance of good research to the success of the fisheries in the IPFC region, and the role that the Committee could play in stimulating and supporting research. He noted that the Committee had been given very wide terms of reference, which could not all be covered adequately at any one meeting. Thus the present meeting would not be expected to discuss inland fisheries and aquaculture, tunas (except marginally) or fish technology and processing, all of which were being discussed by working parties of IPFC. At the same time it would probably not be appropriate to change the terms of reference of the Committee. Rather it should be able at each meeting to concentrate on the aspects which seemed to require particular attention from the Committee and the Commission.

A number of documents were prepared for the meeting by the Secretariat and by individual scientists, and these are listed in Appendix 3. A selection of these papers, which are believed to be of more than temporary interest, are included in the published version of this report.

NEW APPROACHES TO RESOURCE ASSESSMENT IN TROPICAL WATERS

3. The discussion of this item was based on the short working paper (IPFC:RRD/82/5), prepared by the Secretariat, a number of written and oral presentations by national delegations on the work being done on resource assessment and the problems involved, and two papers (Inf.12 and Inf.20) on new techniques. It was suggested in discussions that the basic problems being faced by countries did not seem to have changed much since the first meeting of IPFC in Singapore, 1949; data are still unreliable and incomplete, there are insufficient scientists to do the work, and there is a lack of appropriate techniques for carrying out assessments particularly in tropical multispecies fisheries. In practice the Committee felt that there has been progress; data have improved, more scientists have been trained, and it is clearer to what extent assessment studies can be made more useful by being focussed specifically on the more urgent problems faced by each country.

(a) Objectives

4. One common denominator in the discussions was the lack of clearly stated national objectives for which the results of stock assessments are needed. Purely biological objectives (e.g., maximizing the yield of fish from a particular stock) are likely to be less important than economic or social objectives (e.g., increasing the net economic returns from the fishery, improving the well being of small-scale fishermen, etc.). Yet in some cases policies seem to be advocated which are incompatible or even mutually exclusive, for example, maximizing employment and increasing the earnings of the individual fisherman. Although not considered in detail, it was stressed that economic and social questions do lie within the general terms of the reference of the Committee, and may merit more extensive examination at some future session.

5. In practice it will often happen that fishery scientists will, because they are in day-to-day contact with the fisherman in collecting samples, etc., be more familiar with the practical aspects of a fishery than economists and other experts. The scientists should then feel able to include economic or other non-biological considerations when offering

advice to administrators, e.g., on the desirability of imposing some management measure. This should be welcomed, provided it is recognized where the scientist has gone beyond his direct professional expertise and support from other skills is necessary.

6. Economics and other data are particularly vital when considering the practicability of developing fisheries on stocks of fish that are at present lightly or not exploited. As was pointed out also when discussing squids (which appear to include some of the larger unexploited resources in the region) it is not sufficient to know that a certain resource has the biological potential to produce tens or hundreds of thousands of tons annually. Development also requires the knowledge of how the fish can be caught economically and how they are to be processed and marketed.

7. The demands for stock assessment advice are increasing. Many stocks, especially in near-shore waters, are heavily fished and need managing. Advice is needed for national planning and management of these stocks, as well as on the possibilities of increasing production from resources further off-shore, either as an additional source of food, or a place to divert the surplus effort from the in-shore resources. The emerging law of the sea places the responsibility on the coastal States to determine the potential of the resources in their new Exclusive Economic Zones and to manage them.

8. It was pointed out that the operations of foreign vessels can provide useful information on the potentials of the off-shore areas. As a general rule it was suggested that if there was no great amount of foreign fishing in the period before the introduction of EEZ, then no major resources exist. Clearly this is not absolute, since the resources may be of a kind that is not attractive to the long-range fleets - though in that case it may be questioned whether they are attractive to the coastal State. On this basis the prospects for off-shore developments in the IPFC region may not be good, since with a few exceptions (tuna, trawling in the Arafura Sea, N.W. Australia and New Zealand) catches by the long-range vessels have been small. For example, though there has been no large-scale foreign fishery in the area, a crude examination of a chart might suggest that the Great Australian Bight would be a good trawling area. Failures of two large commercial enterprises and repeated surveys have shown that this is not the case. Controlled operations of foreign vessels may also, under the new regime of the sea, be the most suitable way of finding out whether good off-shore resources exist, and if so, their distribution and approximate magnitude. The coastal State should apply appropriate controls, e.g., placing observers on board each licenced vessel to ensure that they get full information.

(b) Outputs

9. Much more is therefore now required from stock assessment studies than just an estimate of the potential yield, especially if this is not specified according to the type of resource. The particular case of India was discussed, as an example, at some length. Estimates of the potential yield from the Indian EEZ range from 3.5 million tons to 6.5 million tons. Extensive argument as to which of these estimates is correct - or indeed whether, as may well be the case, the true value may be less than 3.5 million tons - is not a high priority in making policy decisions at the present time. The fact that the current Indian catch is much less than even the most conservative estimate of total potential is not a good guide for the policy makers. Within the total (whatever it may be) there are some stocks (e.g., shrimp in the west coast) that are fully exploited and others (off-shore stocks in deeper water) that are unexploited, and, to a large extent even unknown. What is needed in order to take rational decisions on the possible expansion of Indian fisheries is an indication of which stocks can be more heavily fished, and, for these stocks, information on their distribution, the seasonal patterns, the most appropriate type of fishing gear and likely catch rates, the likely markets, and, bringing all this together, an appraisal of the likely costs and returns of a commercial fishery.

10. The details required of the economic appraisal to be carried out by governments vary with the economic structure of the country. In a capitalist-free enterprise system, most of the economic judgement tends to have been left to the individual fisherman or fishing company, although without adequate central government control, competition has led to overcapitalization

and net loss to the country. However in many IPFC countries the decisions on large-scale investment in fisheries are taken by government or quasi-governmental institutions including international development banks. These institutions need much more detailed economic appraisal. It was noted that for structural reasons - it costs almost as much to administer a loan for five vessels as for 100 vessels - many of these institutions prefer large projects. However the history of fishery development, e.g., trawling in the Gulf of Thailand, shows that if conditions are suitable, even very small initial investments will grow very quickly until the limits of the potential of the resource bring growth to a stop. If conditions are not favourable larger investment merely increases the losses. The Committee recommended therefore that the attention of funding agencies should be drawn to the desirability of limiting the size of initial investments in new fisheries to the minimum needed to demonstrate the economic viability of the fishery. In any case, and especially if anything more than a minimum scale of investment was being considered, decisions on the building of new boats, or shore facilities, must be preceded by adequate assessment studies to establish whether the resource can support the project catches.

11. Similarly, for heavily-exploited stocks, more is needed than a statement that the current catches are approaching, or have passed, the potential, or Maximum Sustainable Yield. Guidance is needed on the effects of changing the amount or pattern of fishing on the catch per unit effort, the returns to the individual fisherman, and on the total economic return from the fishery as well as on the total catch.

12. The increasing detail required in the output from stock assessment studies means that close links are needed between the stock assessment expert and the users of his results, particularly the manager. It was felt that, as is the case in many other parts of the world, these links are, in many countries of IPFC, not strong enough. This matter of communication between the various groups concerned with fishery management has been discussed, *inter alia*, by a Working Party of FAO's Advisory Committee on Marine Resource Research (ACMRR). The Committee recommended that the conclusions of this Working Party, and the need to strengthen the links between assessment scientists and administrators and other users of the results, should be drawn to the attention of IPFC.

(c) Basic methods

13. As discussed in the national reports (see Annexes), four basic methods have been used to make assessments:

(i) estimation from figures of biomass or standing stock;

(ii) production models, such as the Schaefer or Fox models;

(iii) analytic, or yield-per-recruit models;

(iv) extrapolation from other areas of similar ecological characteristics, usually on the basis of a figure of potential yield per unit area.

14. Biomass figures have been taken either from trawl surveys, on the basis of the area swept or from acoustic surveys. They have been particularly useful before exploitation starts, and have therefore been used, *inter alia*, for the stocks of pelagic fish off Bangladesh (from acoustic surveys), and for the demersal stocks off Malaysia (from swept area of trawls).

15. Production models have been the most widely-used method. They make least demands on data, and, even though there are reservations about the statistics of catch and effort, have been used for all the Indonesian fisheries, and for many of the stocks off Malaysia and the Philippines. By using cpue data from regular resource surveys, a more reliable estimate of abundance has been made available, and has been incorporated in production models of the demersal resources of the Gulf of Thailand.

16. Analytic models give more detailed information, but require more data. They have, therefore, only been used for a few stocks in tropical parts of the IPFC region for which extensive data exists. These include several Australian shrimp stocks, and Rastrelliger in the Gulf of Thailand.

17. Extrapolation from other areas has been widely used in fresh waters, notably lakes in Africa and North America, but the only current application reported at the meeting for IPFC stocks was for Papua New Guinea, where a figure of 1.5-3.0 t/km^2 has been used to obtain a first estimate of potential of shelf areas.

(d) Surveys

18. The chief problem in applying the first method has been obtaining a satisfactory estimate of biomass. Because of seasonal or longer-term fluctuations in the distribution and abundance of the stocks, the usefulness of a single survey is limited, especially for pelagic species. Here it is noted that, even in the absence of exploitation, most stocks are subject to variation, and it cannot be assumed that the pre-exploitation abundance is constant. It was also stressed that, in many applications of the biomass method, the degree of precision required may be quite small, e.g., merely to establish that a substantial resource exists, and that, therefore, repeated and extensive surveys may not be required. However a distinction should be made between pre-exploitation surveys, to provide an initial estimate of biomass and potential yield, and regular monitoring surveys (e.g., the trawl surveys in the Gulf of Thailand) which are carried out at regular intervals to determine changes in the abundance of the stock.

19. For demersal fish the main reliance, for both types of survey, has been on trawls. No particular problem was reported on the use of trawl surveys, though the danger was stressed (e.g., in the case of Malaysia) of extrapolating the results of existing surveys into deeper waters where the species are different and the abundance is less. For rough-bottom areas in the South China Sea bottom long-lines have been more useful than trawls.

20. For pelagic fish, the main method dicussed was the use of acoustics, though aircraft spotting has been used extensively in the region, particularly for surface-swimming tunas. Conflicting reports were given on the value of acoustic surveys, which are relied on quite strongly by some countries, while others had found difficulties in application. These difficulties included the identification of the species (especially when several species are present with different target strengths), measurement of target strength, and the fact that in some areas much of the stock is in the surface layers where they may be either above the effective sampling level of the equipment or be scattered by the presence of the survey vessel. The seriousness of these problems varies from area to area. The method is most useful when pelagic fish are abundant, and only one, or a small number of species are present (e.g., off Peru or Norway, or within IPFC, off the southwest coast of India or in the Bali Strait). Elsewhere the results may need to be interpreted with caution, though they may be sufficiently valuable for providing initial, pre-exploitation estimates of biomass and potential. Mention was made of the symposium on Fishery Acoustics organized by ICES with support from FAO, to be held in Bergen, Norway, in June 1982.

21. The use of plankton surveys for eggs or larvae as estimators of stock size has been limited in the IPFC region, though they have been used in Japan for sardine and mackerel and in New Zealand for snapper. In the tropical areas there are severe difficulties - the very short development time (many eggs hatch within eight hours of spawning), the variety of species, the fact that perhaps most eggs cannot be identified, and the high variability, and hence high cost required to reach a given precision. It was felt that there was little justification for carrying out such surveys primarily for fishery purposes. However, plankton samples are often collected for other purposes, e.g., as part of university studies, and examination of these data can provide valuable fishery data, e.g., on the occurrence of species of fish not well sampled in other ways, or on the location of spawning concentrations (useful for management, or as evidence of stock separation). Collaboration between fishery laboratories and other research institutions to examine such data should, therefore, be encouraged. In this context it was noted that IOC, as part of its WESTPAC programme of identifying areas of high productivity, recognized the importance of egg and larval identificatio

22. Operating research vessels for surveying or other purposes is expensive. For executing specific surveys of limited duration there are several advantages in chartering a vessel for the period of the survey, as was being considered by Malaysia for her deep-sea resources survey programme. This means that the capacity of the vessel can be closely matched to the needs of the survey, and there are no problems of finding employment for the vessel on the conclusion of the survey. On the other hand for monitoring purposes continuity of standards was required. Some concern was expressed that some bilateral aid agencies were offering countries research vessels without full consideration of the continuing costs involved (fuel, maintenance, etc.), and of the need to have adequate scientific staff and shore facilities to work up the data collected at sea. The Committee recommended that the attention of aid agencies should be drawn to these questions of funding the continued operations of research vessels and welcomed the action being taken by FAO to prepare guidelines on the use of research vessels.

(e) Production models

23. The chief practical problem met in applying production models has been the lack of adequate input data, i.e., estimates of total catch, and indices of either abundance or total effort. Some information on the size of the total catch is essential for any assessment of the state of the stocks, but it was stressed that this does not mean that attempts should be made to collect data from all fish-landing places at all times. Well-designed sampling surveys can provide estimates of the total catch at acceptable levels of precision.

24. Because of difficulties of interpreting commercial catch per unit effort data, several countries (Thailand, Malaysia) are using cpue data from monitoring surveys. Where the size of the fishery can justify the cost, this is a good solution. Otherwise it is necessary to look for some sector of the fishery where cpue data, even in a crude measure, e.g., catch per fisherman, can provide some index of changes in abundance. It was noted that despite these difficulties in commercial data, the cpue of commercial and survey vessels in Malaysia showed quite similar, and serious, declines in stock abundance.

25. The theoretical problems concern whether models derived from single species can be applied to multi-species fisheries and, if so, the form that the yield curve could take. It was felt that, with reasonable care, production models can be applied to multi-species fisheries, and may, indeed, give more reliable information than independent yield curves of individual species. Some experience in the IPFC region confirms that reported from other regions that the maximum total yield is less than the sum of the maximum yields from individual stocks. The forms of the yield curve are likely to be skewed from the simple (Schaefer) parabola in the direction of a fairly flat curve at high levels of effort, with the maximum occurring at an abundance less, and perhaps considerably less, than half the initial abundance. However, this maximum yield is not much greater than that taken when the abundance has fallen to half, and this level of abundance thus provides a useful target for preliminary management of a developing fishery. However, it was also noted that in multi-species fisheries the flattened part of the curve relating to total catch to effort could mask changes in species composition of the catches and that though total production might not decline, the net economic value of the species mix in the catches could do so.

(f) Analytic models

26. The problem in using analytic models is the scarcity of input data of all kinds. This is generally appreciated, but not particular solution was discussed, except the use of length-structured, rather than age-structured models, to avoid the difficulties of aging tropical fish (see section (i) New techniques).

27. Extrapolation from one area to another has been used in IPFC, but was not discussed by the Committee. It might, however, merit discussion at a future session, possibly in relation to some specific ecosystem, e.g., coral reefs.

(g) Tagging

28. This is a technique that has a number of uses - to determine stock structure, migration, growth, mortality, etc. Members of the Committee seemed to hold divergent views on the value of tagging. This reflected the difference between a well-planned tagging experiment aimed at answering some specific question and haphazard tagging executed with no clear question in mind. There can be severe practical problems to be solved even before a specific experiment can be designed. It may be difficult to catch delicate fish, or fish from deep water, in a suitable condition for tagging; the tag may not stay on long, and if re-captured, tags may not be returned, especially from isolated communities - for example, if there is no local fishery officer to receive tags, the costs of postage, etc., may exceed the reward. These problems are common throughout most of the IPFC region. The Committee noted the value of the exchange of information on tuna tagging organized by Dr Bayliff, and suggested that some similar arrangements should be made in the IPFC region for general tagging information - methods of capture and handling; types of tag and systems of rewards. Dr Sainsbury stated that he might be able to make an initial compilation of this information from national scientists, and the representatives of ICLARM stated that it might be able to assist the dissemination through its proposed network of stock assessment workers. The Committee therefore recommended that the Secretariat should examine ways to establish a system for exchanging tagging information.

29. Given the problems involved, it was felt that, except under special circumstances, tagging experiments in the IPFC region were unlikely to provide good estimates of mortality, and that tagging experiments were more likely to be useful in determining migration and stock structure and identification of shared stocks, but only if arrangements were made to ensure that all recaptured tags were returned, wherever the fish moved to. It was noted that SEAFDEC was planning to hold a workshop on tagging methods in 1983. The Committee welcomed this proposal, and urged SEAFDEC to seek the cooperation of FAO and other agencies in planning and implementing this workshop.

(h) Application of assessment results

30. The application of the results of stock assessment studies must be treated as an iterative process. The details and precision required will change as the fishery develops. In the early stages emphasis may be given to the establishment of an appropriate monitoring system. The discussions centred around the needs of Papua New Guinea, but the general conclusions are of wide relevance. Preliminary estimates of potential, based on a figure of expected yield per unit area are very much in excess of current catches in Papua New Guinea. It was felt that, provided some attention was given to the breakdown of this figure and of the current catches by area and type of resource, refinement of this figure did not merit high priority. What was needed was a good monitoring system, and a satisfactory management mechanism to ensure that action is taken to slow down or halt development as soon as the monitoring system shows that action is needed. The sensitivity needed in the monitoring will depend on the speed of reaction of the management systems. Changes in fishing practice, e.g., a shift away from the original centres of exploitation, may mean that looking at crude figures of total catch and total effort may not detect local stock depletion. However, provided the scientists are, as they should be, familiar with the fishery, much can be learnt from catch and effort data. This does need to be accompanied by collection of data on the species composition, and of the size composition of at least some key species.

31. There was considerable discussion of the changes in species composition to be expected as a multi-species community becomes more heavily exploited. Some species, e.g., *Lactarius lactarius* appear to be particularly sensitive to exploitation, and have declined very seriously in some of the more heavily-exploited areas of Southeast Asia. Monitoring of these species may provide early warning of the impact of fishing on the community as a whole. These species are generally the larger, longer-lived, and more valuable species, but not necessarily so. For example, *Leiognathus* species have declined very greatly in the Gulf of Thailand and in parts of the Philippines (but not apparently on the west coast of India). There was some discussion of the degree of concern that should be given to the decline or even disappearance of individual species, but with no clear consensus. It may be that some

of these species play a key role in the ecosystem, but more likely that, provided primary production is untouched and no key species disappears, the flow of energy through the system, and the availability of fish (of one kind or another) to harvest, will not be greatly changed. It is probable, therefore, that the disappearance of some vulnerable species from the catches will have to be accepted as one price of having a high total catch.

(i) New techniques

32. Dr Pauly presented the paper (Inf.12) reporting on the new techniques being developed at ICLARM and elsewhere, on the use of length data. To a large extent, the development of these techniques has resulted from the increasing availability of programmable calculators and the mini- and micro-computers described in the USA report (Inf.20). These new techniques were strongly welcomed by the Committee as providing much greater opportunities for assessing tropical fish stocks. It was stressed that these models did not require any fundamentally new concepts or assumptions in addition to those contained in the more traditional age-structured models.

33. These new techniques, and new computer hardware, make it possible to re-analyse old data in new and more effective ways. It was pointed out that there was, throughout the IPFC region, a great mass of valuable data on sizes of fish, etc., which it has not been possible, up to now, to analyse in detail. The Committee therefore recommended that special efforts should be made to study data collected in past years, for which new techniques of analysis are now available. The Committee also noted that there has been a common failing in funding research and surveys in that inadequate support has been given to the essential work of analysing and publishing the results. The Committee recommended that more attention should be given by agencies to the support for the analysis and publication of results when funding survey and research work.

34. The advances in computing involve software as much as hardware. There are now in existence a great variety of programmes of basic fishery techniques, suitable for various types of machines from hand-held calculators to large computers. It is obviously desirable that anyone planning to write and to use such a programme should be aware of what already exists. At the same time there can be considerable difficulties in transferring a programme from one machine to another - even one of the same type and using nominally the same language. There are, therefore, problems in attempting to establish a library of basic fishery programmes. Nevertheless, the Committee noted the action along these lines being taken by FAO and others, and hoped they would be encouraged.

(j) Other marine stocks

35. Fish stocks do not live in isolation. Assessment studies must take account of the relevant events in the marine ecosystem as a whole. The Committee, therefore, heard with interest from the observer from IOC, Dr Keeley, on the activities of WESTPAC, which covers very much the same region as IPFC and noted the circulated paper (Inf.21). Of the four major programmes established by WESTPAC, that on marine biology and living resources research was of particular interest to SCORRAD, and the Committee hoped that it would continue to be informed about these activities. The Committee also heard with interest on the programme of Ocean Sciences in relation to Living Resources, which is being developed by IOC in collaboration with FAO.

SQUID: IDENTIFICATION, BIOLOGY, DISTRIBUTION AND ASSESSMENT

36. Interest in cephalopods, and in squid in particular, has become large in many IPFC countries. It is felt that these animals represent one of the major groups of under-exploited resources but which should be more readily marketable than krill or meso-pelagic resources. New methods of catching (e.g., gillnetting) and the opening of markets outside the traditional centres of Japan and the Mediterranean (e.g., in Australia) have improved the prospects of making use of these animals. This interest was reflected in the number of reports on national squid fisheries received from nearly all countries participating in the meeting (see Annex 5).

(a) Biological information

37. Despite this interest, information on much of the basic biological characteristics and life-history is missing, or is available for only one or two species, which may not be typical. Anyone attempting to assess a squid stock is unlikely to have the basic understanding of the animal he or she is dealing with, and therefore risks applying quite inappropriate methods, or at least using quite inappropriate parameter values in the models. The scientist does not even have much opportunity of extrapolating from related, but better known, species. Some uncertainties that were mentioned included,(i) whether the short-life span of one year and high post-spawning mortality observed in some stocks, e.g., off California, is typical of all or most cephalopods; (ii) the position - on the bottom, or in mid-water - and geographical location of the spawning grounds of most species; (iii) the behaviour and distribution of stocks relative to water-masses or bottom topography.

38. It was pointed out that there was much information on squid biology arising from research by universities or other institutions which was not immediately available in the normal fishery literature. It could, however, be retrieved by a search of a relevant information system (e.g., ASFIS). The Committee therefore recommended that FAO arrange for a review of published information on cephalopods relevant to fisheries.

(b) Species identification

39. Squids are not all the same. There are great differences between species in their distribution and behaviour, availability to different types of fishing gear, individual size, market acceptability, etc. Much of the confusion about squids arises from the lack of clarity as to what species is being talked about. In addition, there are considerable uncertainties about the identification of species. For example, in the important fishery off New Zealand, it has only recently been shown that there are two distinct species, with different market prices, as well as different biology and distribution.

40. Two recent workshops - at Melbourne, Australia 1/ and Plymouth, U.K. 2/ - have dealt wholly or in part with various aspects of squid identification, and considerable progress has been made. This improved taxonomic knowledge now needs to be made available in forms that can be used by fishery workers in the field. The Committee therefore considered the work being done in FAO on the preparation of a World Catalogue of Cephalopods, and for Species Identification Sheets for Cephalopods, was very valuable and urgent. It hoped that this work would continue to receive the support of taxonomic experts in the region.

(c) Assessment methods

41. Assessment of squids may be done in broadly the same way as assessment of fish stocks, and broadly the same problems are met. A special problem in surveying squid, to get an absolute or relative measure of biomass, is to find the most appropriate gear. Acoustics are of little use, nor are trawls, except for those species that occur on the shelf areas on or close to the bottom. The commercial gears - jigging or gillnets - can be used, but the results cannot be expressed as quantities per unit area, and it may be that the absence of catches represents a low availability to the gear rather than an absence of squid. However, qualitative evidence of this occurrence can be obtained from examination of stomachs of sperm whales, birds, shark, tuna, etc. Several examples of this were given, e.g., tuna off the Indian Ocean coast of Indonesia, sharks on the Australian northwest shelf. It was, however, stressed that the squids occurring in predators' stomachs were not always those species that are suitable for commercial exploitation.

1/ Information available from: Dr Clyde F.E. Roper, Dept. of Invertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560, USA

2/ Information available from: Dr Malcolm Clarke, Marine Biological Association, The Citadel, Citadel Hill, Plymouth, England, UK

42. Choice of a suitable effort unit to determine cpue is a problem, with the probable exceptions of those species that occur in the multi-species trawl fisheries. Even here a minor change in rigging, e.g., increased headline height as a result of increased market demand can affect cpue data from commercial fisheries, but should not affect data from monitoring surveys. It was suggested that the power of the lights used in jigging, e.g., expressed as kW, might be suitable, though it was also suggested that increased catches by vessels with brighter lights reflected competition between adjacent vessels, rather than a real increase in fishing power.

43. Past data on catches of squid in mixed fisheries are unreliable because they have been considered as trash species and discarded, or used as bait without being recorded. This makes difficult any interpretation of historic trends. Where squid are now being marketed at good prices the data are better - at least no worse than other fishing statistics - but there are probably still fisheries where catches of squid are inadequately recorded.

44. In the Gulf of Thailand, where there is a long series of survey data, it has been possible to demonstrate clearly changes in squid abundance; there has been a definite increase as other groups decline. Simulation studies suggest that this increase cannot be accounted for by reduced predation on adult squid, but must be due at least in part to reduced predation on pre-recruits or other factors. It was also noted that some economic evaluation of the total fisheries could help fisheries managers. Where squid were becoming dominant because of removal of other valuable predators, the net economic return to the fishery might also be undergoing change which could be either beneficial or harmful depending upon the relative abundance and unit value of the species concerned.

(d) The magnitude of the resources in the IPFC region

45. Assessment, using a production model of the stock of squid in the Gulf of Thailand, suggests that this stock is approximately fully exploited, with a maximum yield, under the present pattern of exploitation of the other species, of about 40 000 t annually. The MSY for the Andaman Sea was similarly estimated as a little under 6 000 t. Attempts have been made to assess the squid stocks around New Zealand, but there are uncertainties about many of the input data, e.g., regarding the area swept by the trawls used in the survey.

46. Elsewhere no quantitative assessments have been attempted. The Committee considered the possibility of making qualitative statements about the magnitude and distribution of squid resources in the warmer parts of the IPFC region, as a guide for national research and development planning, but it was felt that with the current state of knowledge, such an attempt would be premature and possibly misleading. The distinction was emphasized between the cephalopods of the shallower parts of the continental shelf, and the oceanic squid. Assessment, at least in qualitative terms, is much easier for the former. They are likely to occur as incidental catches in trawls and other gear even in the absence of a directed squid fishery. Large undetected stocks are therefore unlikely to exist.

47. If there are any big resources, they are of the oceanic species. The distribution of this second group is not uniform, and, though it is not possible to predict where the most promising areas are, it would certainly be unwise for any country to assume, in advance of further research, that the waters off their coasts contained large unexploited stocks of squid. In this connexion, the value of allowing foreign vessels to carry out trail fishing under licence, was again mentioned. It was also stressed that the catches from such fishing can be highly variable and trials over a continued period may be necessary to establish the economic feasibility.

(e) Management

48. The techniques that might be used in managing cephalopod fisheries were briefly reviewed, with special reference to the Japanese experience. Particular concern had been expressed about the possible harmful impact of the growing gillnet fishery on the long-established jigging fisheries. Measures have been introduced to limit the competition between large boats and coastal fishermen, as well as to protect small cephalopods, and to enhance

the spawning success. Off New Zealand the number of jig boats has been limited as a way of limiting effort. Elsewhere the fisheries do not seem to have developed to the stage of needing management.

(f) Other aspects

49. At the present stage in the development of squid fishing, information on processing and marketing is clearly very important. It was recommended that this need for information on squid processing and marketing should be drawn to the attention of the IPFC Working Party on Fish Technology. The work of the FAO/UNDP INFOFISH project in disseminating market information was also welcomed (see Inf.8(i)).

SHRIMP FISHERIES: EXAMINATION OF CONCLUSIONS OF FAO/NMFS WORKSHOP RELATIVE TO RESEARCH IN THE IPFC REGION

50. The Secretary reviewed the results of the workshop on the Scientific Basis for the Management of Penaeid Shrimps, held in Key West, Florida, USA, in November 1981. This had been attended by scientists from several of the IPFC countries with substantial shrimp fisheries. Information was also presented regarding some of the national shrimp fisheries (see Inf.9, Inf.9 (Sup.1), and Inf.9 (Sup.2)). The discussions of the Committee concentrated on those matters arising from the workshop that were particularly relevant to conditions in the region.

(a) Statistics

51. The poor quality of statistical data from artisanal fisheries was recognized. Because of the high value not much of the catches are consumed locally, but are exported or sent to large towns. It was therefore suggested that examination of commodity data (especially of frozen shrimp, exports, and sales of local salted or dried shrimp) could provide useful information. The value of the log book in getting data from the larger shrimp trawlers was also recognized, though it was stressed that the amount of detail required should take account of the nature of the fishery and the amount of time the fisherman has for recording data. For example, in the peak fishery on schooling banana prawns every minute counts, and only daily catch records are asked for.

(b) Methods of analysis

52. The community in which shrimp live is, in many cases, changing due to heavy exploitation, e.g., in the Gulf of Thailand. The changes often involve the reduction of predators on shrimp. It was therefore questioned whether the assumptions of a constant value of natural mortality, M, or the use of a "standard" value of M that can be extrapolated from one stock to another, were justified. As an alternative approach to using analytic or production models for which the supply of data may be inadequate, it was suggested that more attention should be given to comparison between areas. In particular, comparison of yields per unit area might provide estimates of potential yield, and figures of the number of fishermen per unit area or per unit length of coastline could provide relative indices of the intensity of exploitation.

(c) Environment

53. There was considerable discussion of the impact of changes in the coastal zone on shrimp. Though much of the discussion focussed on the effects of the destruction of mangroves, it was believed that this was an important case, but that attention should be given to any change in the immediate coastal zone. Though most species of shrimp have nursery grounds in the coastal zone, there is no evidence of their dependence on mangroves, but rather on areas of high productivity. It was also noted that away from the coastal zone, intense logging in upland areas in some parts of Southeast Asia is causing heavy run-off of terrestrial material into the sea. This may possibly mask any more direct effect of local changes in the coastal zone. Although the association between shrimp and productive areas in the coastal zone is generally accepted, there is little information on the form of this relation, and of the quantitative impact on shrimp catches of changes in the coastal zone, for example, the destruction of a given area of mangroves. This information is, however, very important when representations are being made by fishery departments to planning authorities. The Committee therefore heard with interest of the studies aimed at economic assessment being made at Griffith University, Queensland. It is hoped that information could be made available on the methodologies being employed, and the results obtained.

54. The choice between preservation of the coastal environment for the benefit, *inter alia*, of shrimp fishermen, and its use for other purposes (wood from mangroves, aquaculture, housing, etc.) raises very important and general environment principles. These have been spelt out in the World Conservation Strategy, prepared by IUCN, with the support of FAO and other agencies. The Committee heard with interest that the principles in this Strategy are now being explicitly incorporated in Australian policy. The Committee also noted that IOC/Unesco has established a group to look at mangrove ecology and urged that links should be maintained between this group and shrimp biologists.

(d) State of resources

55. It was agreed that in the IPFC virtually all the stocks of larger penaeid shrimp in shallow water are already heavily fished. Some opportunity exists for increasing catches of *Heterocarpus* and other species from deep water. Though locally important, e.g., around many Pacific slands, their total potential is relatively small. The possibilities for deep-water shrimp should therefore not be an excuse for directing attention away from the urgent problems of the shallow-water fisheries. The question of shared stocks was raised. It was agreed that in the IPFC region interchange of shrimp across national boundaries was not large.

(e) Management

56. Dr Latif reported on the mesh selection experiments being carried out by Malaysia in response to the recommendations of the second session of SCORRAD.

57. It was noted that this was only a preliminary report, and the data still had to be fully worked up. The preliminary results were interesting; from using covered codends it was shown that the larger - 1½ in (38 mm) - mesh size did generally release larger quantities of small fish and shrimp than a 1-in mesh. Direct comparison suggested that the total catches with the larger codend mesh could be either larger or smaller than that with a 1-in mesh. Apart from examining the statistical significance of these results, the full analysis should cover the following points:

(i) possible increase in fishing power of the larger mesh (due, e.g., to better flow of water through the net) as measured by the relative catches of large shrimp and fish;

(ii) the immediate effects of the escapements of small shrimp and fish through the meshes;

(iii) the long-term effects of this escapement, as the released fish and shrimp grow enough to be retained by the new mesh size.

The two last points will require an examination of the size - composition of the catches and escapement of the main species.

58. It was pointed out that, so far as the selectivity of fish is concerned, sufficient is known to be able to predict with reasonable confidence the escapement from a net of a given mesh size from a knowledge of the shape of this fish. However, considerable uncertainty surrounds the pattern of escapement of shrimp, although it is known to cover a wide range of sizes. The biggest requirements in order to assess the biological effects of a possible increase in mesh is for data on the sizes of fish of the main species in the current catches, and for data on the possible increase in effective fishing power of nets with larger meshes. The possible reduction in fuel consumption with the larger mesh should also be examined.

59. It was also pointed out that, so far as shrimp alone is concerned, protection of the smaller sizes could be done more effectively by prohibiting fishing at times or places when small shrimp are common. The main value of a mesh regulation lies in the potential increase in catches of the larger fish. For example, a high proportion of the so-called trash fish in the Malaysian trawl catches are small individuals of valuable species.

60. In this connexion the closure of the eastern part of the inner Gulf of Thailand to trawling from the end of September to February was noted. If this were purely a measure to protect shrimp, the dates would probably have to be adjusted from year to year to take account of the timing of the peak availability of small shrimp. In fact, the objective of this measure has been to protect the fish as much as the shrimp.

61. The biggest management problem is the conflict between inshore fishermen and large-scale mechanized vessels. It was noted that India, where 65 percent of the shrimp catch is taken by small-scale fishermen, is planning to ban mechanized vessels from within 5 km from the shore, and is considering extending the limit to 10 km. The most drastic action has been taken by Indonesia, which has banned trawling except in the eastern part of the country. Early results show that this has rapidly increased catch rates by inshore fishermen, e.g., in Southern Java. The Committee believed that detailed information on the results of this regulation on stock abundance, total catch and catches by different groups of fishermen, would be of great value to any other country contemplating similar action. The Committee therefore recommended to IPFC that Indonesia be requested to collect information on the impact of the ban on trawling and to make the results of analysing these data available to other IPFC member countries. It would also be valuable to look for alternative methods of harvesting shrimp, e.g., gillnetting or trammel netting.

DEVELOPMENT OF NATIONAL SCIENTIFIC EXPERTISE, PARTICULARLY THE IDENTIFICATION OF TRAINING NEEDS

(a) Scope

62. Training can cover an enormous field. Taking account of its terms of reference and the expertise represented, the Committee felt that it should not look at extension work, or training in the field of fish and fishing technology. However, although most participants were biologists, the discussions should not, it was believed, be restricted to biology. For the research to be relevant, the fishery scientist needs to know how the fishery operates, and what are the practical problems that need to be tackled. To do this, he or she must have some understanding of economic and social matters. Equally, administrators and others dealing directly with other matters must have some grasp of biology and of the fish stocks on which the industry is based. Fishery management is concerned with managing people, not fish, and training of all those likely to be concerned must take this into account. Thus, the discussions took account of the need for training of those working now, or likely to work in the future, in administration or in the higher levels of the fishing industry. Thus they covered much the same field as the Unesco/FAO workshop on Fishery Science Teaching at the university level (Unesco reports in Marine Science 15), whose report, it was felt, gave a useful overview of the subject.

(b) Short-term courses

63. The attention, at least of aid agencies such as UNDP, SIDA, DANIDA, etc., to training has in recent years been focused on relatively short-duration courses, typically from two to six weeks. These are probably the most effective ways of bringing together those already engaged in fisheries and some top scientists in the field.

64. Though it is not possible to give a broad training in a short period, and the substance of the course must concentrate on one specific subject, it should be delivered in a manner that makes clear how that subject fits in the overall fishery scene. Experience has shown that there are problems which, if not dealt with, can greatly reduce the effectiveness of courses. These include:

(i) a poor selection of participants;

(ii) training in appropriate methods;

(iii) poor teachers.

65. Often the organizers of training courses have limited opportunities for selecting candidates who are nominated by their governments. These, of course, may contain people of very mixed attributes or who have inappropriate experience or responsibilities. Much can be done by specifying clearly the qualifications required in potential candidates, and by seeking nominations from fishery departments, rather than other government units.

66. Given the concentration of experience and expertise in fishing science in temperate waters, it is almost inevitable that most of the material presented at courses is based on these fisheries, and that most of the lecturers come from these areas. However, tropical conditions are different and attention should be given to ensuring that the techniques taught, and examples used, are appropriate to the region where the course is being held. Even when the lecturers are familiar with local conditions, they may not be good at teaching. More attention should, therefore, be paid to selecting instructors with teaching skills.

67. The effectiveness of training courses could also be increased by more careful advance planning, for example, by visits of the course organizers to countries to see what is needed, and in follow-up and evaluation after the courses, e.g., by subsequent visits by the lecturers to the institutions of the participants to help them apply the methods that have been taught to the practical problems within their countries. It was noted that this was being done in relation to courses being executed by FAO with support from bilateral agencies (e.g., SIDA, in pollution and DANIDA, in stock assessment).

(d) Long-term training

68. The Committee discussed the need for longer-term training, especially university courses, either for a first degree, or at the post-graduate level. It was agreed that for future fishery scientists a broad training in the basic subjects (biology, mathematics, etc.) at the basic degree level was more useful than a specialized fishery degree. There were, however, considerable advantages in incorporating a course on fisheries within a more broadly-based degree. This would be useful, not only for future fishery scientists, but also for those who would work in the fishing industry of fishery administration. At the post-graduate level it was doubted if the total demand for fishery scientists in many countries would be sufficient to justify such a course. For example, an average intake of five scientists per year was mentioned for Australia. The justification for such a course would be greatly increased if it could serve the region, with intake from several countries.

69. It was, therefore, felt that one or more institutions in the region capable of giving instructions along these lines could fill a useful function. The institution would have to have good links with other groups and particularly, for example, university departments dealing with economics and sociology, technological institutes concerned with fish catching and fish processing, a good library, etc., as well as with industry organizations and access to fishing and research vessels. Because of the general similarity of problems, it might well be linked with an institution dealing with forestry or wildlife - but not with agriculture.

(e) Maintenance of skills

70. Maintaining and increasing skills after receiving training is at least as important as the training itself. This is difficult where, as in most IPFC countries, the scientists are fairly isolated. The Committee, therefore, heard with interest of the ICLARM programme for the development of a network of scientists engaged in the assessment and management in tropical fish stocks (see Inf.12), membership of which will be on an individual (rather than an institutional) basis, and cover the whole world (and not solely the IPFC region). Activities will include the preparation of a newsletter, assistance in getting access to literature, information on new techniques, etc. The Committee therefore recommended that strong support should be given to the concept of the ICLARM network of scientists concerned with the assessment and management of tropical fish stocks.

71. Publications, and the discipline and control involved in the preparation of properly edited and refereed publications, are an important part of improving scientific skills. Several of the countries in the tropical part of IPFC do not have their own fishery journals, while publications abroad can be difficult, e.g., because of page charges. Further, the administrative structure may not encourage publication. The Committee recommended that fishery scientists should be given more encouragement to publish their results, preferably in the region.

(f) Access to literature

72. Books, journals and monographs are among the most important working tools of the scientist, but this is not always appreciated by those funding research. Although the costs are increasing, they are still small compared with, for example, a few days' operation of a research vessel. The Committee recommended that the IPFC draw the attention of its member countries and funding agencies to the need for adequate financing for libraries.

73. Another problem is knowing what literature exists, and is relevant. The trial bibliography prepared by FAO for the IPFC region (Inf.10) was felt to be useful, though its value would be increased by clearer arrangements of the entries under different topics. However, it was felt that it would be better, and the need for a special IPFC bibliography would be reduced,if scientists in the region had better access to ASFA (Aquatic Sciences and Fisheries Abstracts). This is expensive, and librarians are too often unwilling to let it out of the library for extended consultation. The attention of governments, FAO and funding agencies was, therefore, drawn to the need for making ASFA more widely available. Once they have become aware of the existence of relevant papers, librarians and individual scientists should be urged to follow the normal scientific practice of requesting reprints directly from the author. In addition to saving costs by limiting subscriptions only to the key journals, this saves cataloguing and storing irrelevant material.

74. Comprehensive reviews of the state of the art in particular fields were even more useful, by bringing everything together in one place and eliminating the need to refer to a large number of separate papers. Production of such reviews, such as the excellent review of shrimp biology and assessment prepared by Garcia and Le Reste [1/] should be strongly encouraged. However, it is not easy to find people with the time, experience and skills to make such reviews.

75. The value of the FAO manuals and related publications was stressed, though it was noted that,as experience is gained in tropical fisheries, the present emphasis on temperate water experience should be eliminated. It was, however, noted that, despite efforts to improve distribution, these manuals are still hard for working scientists to obtain. In particular, the poor service provided by the FAO sales agents in Australia was mentioned. The FAO manuals were believed to cover most of the field, though the desirability of producing information on the conduct of statistical frame surveys in an accessible form was mentioned.

(g) Other training matters

76. The vital role of technicians in supporting the work of higher-level scientists was stressed. This is, however, often ignored, so that the scientists spend too much of their own time in doing routine work that is better done by technicians. Actions that might be taken to rectify the situation include:

(i) better training - the New Zealand Certificate in Science was mentioned in this regard;

(ii) adequate provision for technicians in the overall research budget;

1/ S. Garcia and L.Le Reste, 1981, Life cycles, dynamics, exploitation and management of coastal penaeid shrimp stocks, Fisheries Technical Paper 203, 215 p.

(iii) adequate pay for the individual technician;

(iv) giving proper feeling of status and responsibility to the technician.

77. The observer from IOC drew attention to the Training, Education and Mutual Assistance Programme (TEMA) of IOC. Though not intended to provide major funding, or to initiate specific training programmes, TEMA does act as a catalyst in both these areas. It was noted that each member country of IOC/WESTPAC has nominated a national contact point for TEMA (listed in Appendix 4). Members of SCORRAD were encouraged to work with these contacts in developing proposals for workshops, seminars, etc., to be sponsored by IOC as TEMA projects.

OTHER MATTERS

(a) Publication of SCORRAD proceedings

78. The Chairman suggested that, taking account of the growing activities of the Committee, its proceedings should appear in an independent and clearly-identifiable form. This was agreed, and FAO was asked to arrange for appropriate publication of the report of the meeting, together with a selection of the papers submitted to the session. These are attached as an appendix to the printed version of the report.

(b) Recommendations for the second session

79. The Committee reviewed the action being taken by countries, IPFC or the FAO Secretariat, to implement the recommendation made at the second session in Hong Kong. It noted that most of these had now been acted on.

(c) Topics for the next session

80. The Chairman invited suggestions for topics to be discussed at the Committee's next session. The examination of methods to reduce excess effort and, bearing in mind the problems of contiguous EEZs, questions of stock identification were suggested as possible matters. However, it was agreed that it would be premature to make a firm decision at this time. This should be done by the officers of the Committee nearer the time of the meeting, taking particular account of the views expressed by the Commission at its forthcoming session in Bali, and the degree to which topics are being discussed by other groups within IPFC.

ELECTION OF CHAIRMAN

81. On the proposal of the delegate of Malaysia, seconded by Japan, Mr R.S. Shomura (USA) was elected Chairman for the period up to and including the next session.

DATE AND PLACE OF THE FOURTH SESSION

82. The next meeting of the Committee should take place within two years. Taking account of other meetings being planned by FAO, a date early in 1984 was suggested. The delegate from Malaysia expressed his hope that it would be possible for a formal invitation for the Committee to meet in Malaysia to be extended at the time of the IPFC session in Bali.

ADOPTION OF THE REPORT

83. This report was adopted on 4 May 1982.

RECOMMENDATIONS

84. The Committee made the following recommendations (the paragraph in which the matter is discussed is given in brackets):

(i) that the attention of funding agencies should be drawn to the desirability of limiting the size of initial investments in new fisheries to the minimum needed to demonstrate the economic viability of the fishery (para.10);

(ii) that the conclusions of the ACMRR Working Party on the Scientific Basis of Management Measures, and the need to strengthen the links between assessment scientists and administrators, and other users of the results /of stock assessment studies/ should be drawn to the attention of IPFC (para.12);

(iii) that the attention of aid agencies should be drawn to the question of funding the continued operations of research vessels (para.21);

(iv) that the Secretariat should examine ways to establish a system for exchanging tagging information (para.28);

(v) that special efforts be made to study data collected in past years, for which new techniques of analysis are now available (para.32);

(vi) that more attention be given by agencies to the support for the analysis and publication of results when funding survey and research work (para.33);

(vii) that FAO arrange for a review of published information on cephalopods relevant to fisheries (para.38);

(viii) that the need for information on squid processing and marketing should be drawn to the attention of the IPFC Working Party on Fish Technology (para.49);

(ix) that IPFC requests Indonesia to collect information on the impact of the ban on trawling, and to make the results of analysing these data available to other IPFC member countries (para.61);

(x) that strong support be given to the concept of the ICLARM network of scientists concerned with the assessment and management of tropical fish stocks;

(xi) that fishery scientists should be given more encouragement to publish their results, preferably in the region;

(xii) that IPFC draws the attention of its member countries and of funding agencies to the need for adequate financing for libraries.

CLOSURE OF THE SESSION

85. In closing the session the Chairman thanked the Australian Government and the Secretaria for the excellent support that had been given to the work of the Committee.

86. The Committee noted that since Dr Waugh would be shortly retiring from Government services, this would be the last session attended by him. The members of the Committee expresse their gratitude for the excellent leadership that he had given to the Committee as its Chairma during its first years of life, and wished him an enjoyable and active retirement.

APPENDIX 1

List of Delegates and Observers

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Fisheries Development Commissioner
Ministry of Agriculture
Departure of Agriculture and Cooperation
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Alternate - DR P.S.B.R. JAMES
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Dean of Science, University of Queensland
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DR ERIK PAUL
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Australian Fishing Industry Council
c/o Craig Mostyn and Co.Pty.Ltd.
Milsons Point

DR J. BUNT
Director, Australian Institute of Marine Science (AIMS)
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APPENDIX 2

Agenda

1. Opening of the session and adoption of the agenda
2. New approaches to resource assessment in tropical waters
3. Squids: identification, biology, distribution and assessment
4. Shrimp fisheries: examination of conclusions of FAO/NMFS Workshop relative to research in the IPFC region
5. Development of national scientific expertise, particularly the identification of training needs
6. Election of officers
7. Any other matters
8. Date and place of the fourth session
9. Adoption of the report

APPENDIX 3

List of Documents

IPFC:RRD/82/1		Provisional agenda
	2	Annotated provisional agenda
	3	Provisional timetable
	4	Problems of applying traditional stock assessment techniques and suggestions for improvement
	5	Review of methods of studying and assessing squid resources
	6	Problems of shrimp research
	7	Training requirements in resources research
	7 (Sup.1)	Development of national scientific expertise particularly the identification of training needs
IPFC:RRD/82/Inf.1		List of documents
	1 (Rev.1)	List of documents (revised)
	1 (Rev.2)	List of documents (revised)
	2	Information for participants
	3	Provisional list of delegates and observers
	3 (Rev.1)	List of delegates and observers
(Withdrawn)	4	Report of Workshop on Multispecies Fisheries, Cronulla, 1981
	5	Progress and problems in national resource studies
	5 (Sup.1)	Stock assessment of New Zealand marine fisheries
	5 (Sup.2)	Progress and problems in national resource studies - Malaysia
	5 (Sup.3)	Marine fishery resources assessment of Thailand
	5 (Sup.4)	A review on the state of fishery resources based on statistical data 1975-79 (Indonesia)
	5 (Sup.5)	Survey on the fisheries resources around Japan
	6	World catalogue of squids
(Withdrawn)	7	Revised and additional Species Identification Sheets for IPFC region
	8 (a)	Review of national squid fisheries - Hong Kong squid fishery
	8 (b)	Review of national squid fisheries - New Zealand squid fishery
	8 (c)	Review of national squid fisheries - Japan squid fisheries - Republic of Korea squid fisheries
	8 (d)	Review of the national squid fisheries - the status of the squid fisheries in the United States of America
	8 (e)	Review of the national squid fisheries - squid and cuttlefish resources of Australian waters

IPFC:RRD/82/Inf.8 (f)		Review of the national squid fisheries - squid fisheries of Thailand
	8 (g)	Review of the national squid fisheries - a small-scale squid fishery in Alas Strait, West Nosatenggara
	8 (h)	Review of the national squid fisheries - The Philippine squid fishery - a review
	8 (i)	The Japanese market review and outlook for squid and cuttlefish
(Withdrawn)	9	Report of the FAO/National Marine Fisheries Service Workshop on the Scientific Basis for the Management of Penaeid Shrimp, Key West, Florida, USA, November 1981
(Reissued)	9	The Hong Kong shrimp trawl fishery
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	10	Selected bibliography for the IPFC region
	11	List of fishery scientists in the Indo-Pacific region
	12	On the development and dissemination of new methodologies for tropical stock assessments
	13	Growth and condition factors of skipjack (*Katsuwonus pelamis*) and yellowfin (*Thunnus albacares*) caught by pole and line gears in eastern Indonesian waters (Sorong, Ternate and Ambon)
	*14	Committee for the Development and Management of Fisheries in the South China Sea: Report of the first session, Manila, The Philippines, 27-30 January 1981
	*15	Induced Fish Breeding in Southeast Asia: Report of a Workshop held in Singapore, 25-28 November 1980 (IDRC)
	*16	Indo-Pacific Fishery Commission Proceedings 19th Session, Kyoto, Japan, 21-30 May 1980. Section I - Report of the Session and of the Indo-Pacific Fishery Commission Symposium on the Development and Management of Small-scale Fisheries. Section II - Report of the Second Session of the IPFC Standing Committee on Resources Research and Development (SCORRAD), Hong Kong, 3-8 December 1979
	17	General information
	18	CSIRO Division of Fisheries Research, Divisional Research Seminar, 1-3 December 1981, CSIRO, Cronulla, NSW, Australia
	19	Approaches to resource assessment for lobster, bottom fish, monk seal, green turtle stocks in the northwestern Hawaiian islands

* Limited number

IPFC:RRD/82/Inf.20	Microcomputers and fisheries
21	Intergovernmental Oceanographic Commission (IOC) Membership of WESTPAC (IOC Programme Group for the Western Pacific)
*22	Report of the Fifty-ninth Session of the Executive Committee of the Indo-Pacific Fishery Commission, Bangkok, Thailand, 21-22 December 1981

* Limited number

APPENDIX 4

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ANNEX 1

Problems of Applying Traditional Stock Assessment Techniques and Suggestions for Improvement

by the

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1. INTRODUCTION

Stock assessment work, as carried out in the typical government research institute, consists of three phases - the collection of data, its analysis, and the provision of advice to users (planners, industry, etc.). Where stocks are heavily fished the advice is increasingly concerned with the management of the fishery. In reviewing the techniques used, this note will be primarily concerned with the analysis stage, but since what can be done is constrained by what data are available, and what should be done is constrained by what the results are used for, the availability of data, and the advice produced will also be looked at.

2. PROVISION OF ADVICE, AND THE USE OF ASSESSMENTS

Given the complexity and extent of the fisheries in the Indo-Pacific region, the inadequacies in much of the basic data, and the relatively small number of scientists engaged in stock assessment work, it is impossible to produce comprehensive and detailed assessments of all the stocks in the region. However, complete assessments are not essential. What is essential is that those making decisions have sufficiently good assessment advice for them to make appropriate decisions. To do this is a more reasonable task. While it still may be beyond the capacity presently available to collect and analyse data, the degree to which inadequate advice results losses to the fisheries from poor decision should be a strong argument for giving more support to the collection and analysis of data. At the same time it must be recognized that the institutional and other arrangements for collecting data, analyzing it, and providing advice to administrators and other decision-makers are often not adapted to giving the most effective advice possible with available resources. In many countries research programmes, and the links between the research institutions were set up years ago when the problems that seemed to be facing national fisheries were very different, i.e., those of expanding catches from stocks that were generally lightly fished. Now the most urgent problems are those of limited resources, and of excessive, and expanding, catching capacity. It is likely that some modification in programmes, and the way scientific results are presented to administrators, could help the latter to have more effective advice.

In this respect the current situation in the Indo-Pacific region is somewhat similar to that in the North Atlantic some decades ago. There is an awareness that "overfishing" (in some sense or other) is a serious and growing problem; there are scientific studies to show the effect of heavy fishing on a number of stocks (plaice in the North Sea, or demersal fish generally in the Gulf of Thailand), and the administrators recognize that something needs to be done. What is missing is a machinery for a regular review of what is happening to the stocks, and of the effects of possible management measures. In the North Atlantic such machinery has now been established. In the Northeast Atlantic, where many stocks are of interest to several countries, the review is carried out by the International Council for the Exploration of the Sea (ICES) and its committees and working groups. In the north-west some fisheries are reviewed by the Northwest Atlantic Fisheries Organization (NAFO), but most are done nationally, under slightly different arrangements in Canada (Canadian Fisheries Scientific Advisory Committee), and in the U.S. (regional fishery management councils). In the IPFC region a similar variety of mechanisms (regional, sub-regional or national) might be adopted. The important matter is to have some mechanisms, so that the administrator can have regular and up-to-date advice, and the research is directed along the most useful lines.

3. DATA SOURCES

Data used for stock assessment include statistics from the fisheries themselves, the results of surveys, and of other biological studies. Some estimate of total catch is essential for any assessment of the state of the resource. In the IPFC region statistics of total catch are probably, with some

exceptions, fairly reliable. This is not true of the details generally available - catches of particular species, or in particular areas -though more details than those contained in national statistics may be available in local or provincial offices. Effort data, in a sophisticated form (e.g., hours fishing by a certain tonnage class, in a certain 1^{0} statistical square) is generally absent, but simpler data (number of vessels or fishermen, using a particular type of gear in a particular administrative region) are available, and can probably be used, with caution, to a greater extent than has been the case so far.

Considerable attention has been given to the collection of survey data, and for some fisheries (e.g., the demersal fisheries of the Gulf of Thailand), the survey data are as good as those anywhere in the world. Surveys can produce either an absolute measure of abundance (so many tons of fish), or an index (so many kg/hour) which will reflect changes in abundance from one survey to another. Acoustic surveys tend to be considered as producing an absolute measure, though in the conditions of the region there can be difficulties of the exact interpretation of acoustic signals, and their allocation to individual species, so that the degree to which they in fact produce reliable estimates of absolute abundance should be looked at carefully. On the other hand trawl surveys are more useful when carried out as part of a regular monitoring survey, and producing indices of abundance. With some exceptions, however, the results of the surveys have not been fully integrated into the stock assessment programmes.

This lack of integration is even more marked in the case of other biological data. In most IPFC countries quite extensive marine biological studies have been made, some in fishery institutes, and some in universities and other places. These range from data that are obviously related to the fisheries, e.g., the sizes of fish in the catches of survey vessels or commercial fishermen, through other studies on the fish themselves (feeding, behaviour, etc.), to more basic studies, e.g., on primary production. These data have, in general, been very little used to make or improve resource assessments. In part this is because there are no obvious methods to incorporate them into the usual stock assessment models.

4. STOCK ASSESSMENT METHODS

Traditionally the best or most proper method of stock assessment has been considered to be the application of analytic models such as those of Beverton and Holt or Ricker. These models may provide a useful approach under the conditions of the North Sea, but they have not been widely used in the IPFC region. The operational difficulty is that the necessary inputs - catch, effort and age data - are seldom available, and it would be an enormous task to collect them for all the species and stocks that contribute significantly to a country's catches. A more fundamental objection is that a series of analyses of a large number of species, considered individually, will, because of interactions between species, fail to give a correct evaluation of the state of the fishery and the fish stocks looked at as a whole.

Nevertheless analytic models could be used more than they are at present. There are a number of fisheries based wholly or largely on a single species (e.g., the Indian oil sardine), for which it is worthwhile collecting the basic data. Even in the multi-species trawl fisheries a yield-per-recruit analysis of some of the main species would give useful information. It might show, on the one hand, that fishing is still very light in terms of yield-per-recruit of that species, and probably therefore, for the fishery as a whole. On the other hand it might show that the fishing effort is approaching or has passed the point of maximum yield-per-recruit. The effect on total yield would not be known with certainty, depending on the effect on recruitment, and the interaction between species, but the analysis would certainly suggest that increased fishing could result in a decrease in catch.

The shortage of age-composition and similar data, and the difficulties of some stages in the analyses, particularly the estimation of natural mortality can be approached in several ways. Length data can be used directly, without conversion to age, using similar techniques to those of traditional age-based analyses (e.g., Jones, FAO Fish.Circ., 734). Some knowledge of the growth pattern is needed, particularly the average time taken for a fish to grow through each length interval, but it is not necessary to know the absolute age of individual fish. Comparisons between species can be used to provide reasonable first approximations of vital parameters, especially natural mortality. Pauly has, for example, shown that a reasonable estimate of M can be obtained from knowledge of the growth parameters, and the average sea temperature for some species.

Most assessments in the region have been made using production models. Often they have been applied to a group of species, e.g., the total catch in demersal trawls. In this case, provided the system adjusts quickly (so that that data can be taken as representing reasonably well a succession of steady states under different intensities of fishing) the results will incorporate the inter-specific reactions, and should therefore be more valuable than single-species analyses. A common problem in applying these models is the lack of good effort data. In some fisheries (e.g., Gulf of Thailand) this has been solved by using survey data to give an index of abundance; this can also be combined with data on the total catch to provide an index of effort, from which a production model can be used in the normal way. Problems have also been met where, as in Korea, recruitment fluctuates greatly, and (at least to some extent) independently of fishing.

In addition to providing input data for production models, the results of surveys have been used directly to provide estimates of sustainable yield. The formula $Y=0.5\ MB_o$, or some similar relation has commonly been used, usually on the explicit or implicit assumption that the stock is unexploited. For exploited stocks, in which the catch, C, is known, the alternative formula $Y=0.5(C + MB)$ has been used.

Other approaches, such as taking a broader view of the whole ecological system, have not been used much in the IPFC region. Information on total primary production in the waters around India and elsewhere have been used, in combination with assumptions about transfer efficiency and the trophic level at which harvesting takes place to produce estimates of total potential catch. These types of estimates often show that taking a large area (say the waters off the west coast of India out to, say, a hundred miles) as a whole the primary production should be sufficient to support fish catches larger than those taken at present. However, they have not generally been integrated with other more traditional stock assessment studies to determine to what extent (if at all) catches from the present stocks, or with the present types of vessel and gear can be increased.

5. OUTPUTS

The outputs from stock assessment studies vary. Ideally they should be matched to the problems of the fisheries, and provide the types of answers needed by administrators and others in tackling these problems. Thus, for a lightly exploited stock, for which investment plans are being considered, they should provide information on the size of the possible catch, and also on the changes in abundance (and in catch rates) which would take place if catches were changed. For heavily exploited stocks more details are likely to be needed. For example, where there are problems of conflicts between inshore fishermen and trawlers, a vital question is the degree to which the inshore catches would be increased if all trawling were stopped, or if it were restricted to waters beyond a certain depth or distance from the coast. The output from the stock assessment studies concerning these fisheries should therefore address this question of conflict. In qualitative terms the output could describe which species migrate between inshore and offshore waters, and which are only found in one or other area. Where possible quantitative advice should also be given on the change in catches by the inshore fishermen as a result of prohibiting trawling completely, or from certain zones.

Sometimes the output of even quite simple stock assessment work does match the current needs of the administrator, especially when these also are simple. For example the acoustic surveys off Bangladesh have provided estimates of the standing stocks of small pelagic fish that range from 60 000 to 120 000 tons. There is at present no fishery for these fish, and this range is probably adequate for the current decision-making needs of the administrator - they show that there is a resource, though of moderate size, so that it would be worthwhile making some efforts, but not very large efforts, into developing a fishery for the pelagic stocks.

More often the administrator's needs are not so simple, and the stock assessment output is not well matched to these needs. For example, to be told, from an acoustic survey, or from other studies, that the potential yield from a stock is between 60 000 and 120 000 tons is not much help when current catches are already 60 000 tons. He wants to know whether catches can be increased or not. Even when presented as single figures, estimates of potential yield, or maximum sustainable yield are, by themselves, only part of the advice that administrators want. A single figure would misrepresent the reliability of most stock assessment studies, which are usually better presented as a range. Further, depending on the national objectives, a target yield somewhat less than the MSY, but which could be

taken with a considerably less cost, would usually be better than the MSY. The administrator will also need information on how the total catch (and the catch per unit effort) will, on the average, change with changes on the amount of fishing, as well as information on the likely variations in catch and c.p.u.e. due to natural fluctuations. For individual fisheries additional information is usually needed, e.g., on the changes that might take place in the relative shares taken by different groups of fishermen. The advice also needs to be matched to any specific actions that are under consideration (e.g., investment in new vessels, assistance to inshore fishermen to purchase outboard engines, or management schemes, including licensing schemes).

6. POSSIBLE NEW APPROACHES

On first sight the situation looks discouraging; present stock assessments are not, on the whole, providing the outputs that administrators need, yet there are grave difficulties in applying them to most fisheries in the IPFC region. The prospects therefore for producing the more extensive advice needed by substantial improvements in the overall standards of the assessment studies seem small. This impression is too pessimistic. It should be possible in many cases to produce more useful outputs by matching the assessment studies to the requirements of the users. Some suggestions will be made on how this might be done in relation to the main types of assessment techniques.

Before using any technique a clearer definition is needed of the kind of output required. This in turn requires some clearer identification of the objectives of fishery policy. If it is the maximization of the long-term yield from a given stock of fish, then the requirements of the policy-maker can probably be met in part by an estimate of the MSY, and of the value of the present fishing effort relative to that giving the MSY. Such estimates should, however, be accompanied by comments on the degree to which the actual yield in any one year may vary above and below this average level, and the advice should point out the advantages that can be gained from a lower fishing effort, with little loss of total catch. This is not the place to add to the debate on the objectives of fishery policy. What must be stressed here is that the objectives are varied, and while a high and substantial volume of total landings is a common objective, maximization of yield from one particular stock is seldom of high priority. Greater priority is commonly given to economic and social objectives. Aspects of the latter, such as maintaining the well-being of particular groups of fishermen, will often require detailed advice of a kind not normally contained in generalized stock assessment studies. What must also be stressed is that before stock assessment studies are started, the scientist should determine, as clearly as possible, what are the objectives of the fishery policy, and what outputs are required from his studies to pursue these objectives. Even in the absence of explicitly stated objectives, it may be worth including, in the advice, some of the types of additional information now being included in some advice outside the IPFC region, e.g., the value of $F_{0.1}$ (the fishing mortality at which the marginal yield, or the increase in the total catch from adding one unit of effort, is one-tenth of that in a newly exploited stock).

Whatever the required output, the commonest assessment technique in the IPFC region will, for the immediate future, continue to be production models, in one form or another. They are well matched to providing the advice often required in that they usually relate the commonest (though not the only) measures of the success of a fishery (total catch, and catch per unit effort), to one of the quantities that is most obviously under the actual or potential control of the policy-maker - the amount of fishing. As used in the region (e.g., by several working groups organized by the FAO/UNDP South China Sea Programme), production models have been applied to the complex of species exploited by a group of gears (e.g., demersal fish caught by trawls). This obviously gives suitable results from the administrators' point of view, especially if the total catch (and catch per unit effort) are expressed in terms of value rather than weight. This would, for example, give a more correct impression of the contribution of shrimp to the trawl fisheries. There are also reasons to suppose that in a typical multi-species fishery, such an analysis is no less realistic from the theoretical and biological point of view than a series of single species analyses.

The biggest problem in applying production models has been to obtain a valid measure of the amount of fishing. This has been obtained either directly, from effort statistics, or indirectly, from indices of abundance obtained from surveys (e.g., in the Gulf of Thailand). Where available, survey data is very satisfactory, but only a very few regular monitoring surveys are now being carried out. Where the importance of the fishery justifies them, further surveys should be instituted, but the costs would

limit this to only the largest fisheries. The inadequacies of current effort statistics are well known, but it may be that in some cases their inadequacies, relative to their use in production models, are overstated. While there are few fisheries for which total effort can be directly derived from existing effort data, in many there is some group of fishermen (e.g., using a particular type of gear in a particular administrative unit) for which available catch and effort data can give an index of abundance, which is reasonably reliable, and which can be used for deriving an index of total effort. A corollary to this is that the immediate emphasis in improving the supply of basic catch and effort data should perhaps be rather narrowly focussed, and addressed to identifying, improving, and extending those sets of catch and effort data which already exist, and for which the catch per unit effort gives an adequate index of abundance. While the second condition will not be satisfied by all data sets - few measures of c.p.u.e. give good indices for shoaling pelagic fish - there are many simple data sets which are satisfactory for demersal and inshore fish. Less emphasis should in that case be given to the wide-ranging activities aimed at collecting comprehensive effort statistics.

The value of the production model approach can be improved by bringing in some of the concepts involved in analytic models. Studies in FAO show that where suitable data exist, the estimates of total mortality (from age or size composition data), can be used instead of effort data, to relate to total catch or catch per unit effort. That is, a plot of catch on total mortality should give a parabola similar to that obtained using the Schaefer model, when plotting catch on effort (except that instead of passing through the origin it will cut the x-axis at the value of average natural mortality). Examinations of the length or age structure can also strengthen the conclusions reached when effort data are available, especially in checking the extent to which there may have been a slow change in fishing power as new methods and gear are introduced. Without such an independent check these are very difficult to detect. If the analysis suggests that abundance (c.p.u.e.) has decreased because of fishing, then presumably the mortality has increased, and thus should be reflected in the size- (or age-) composition. The degree to which the change is detectable in the size data is a function of the range of sizes occurring in the catches. More precisely, in terms of the parameters of the analytic models, it is a function of the ratio of l_c, the size at recruitment, to L_∞, the maximum size reached. If, as is the case of several pelagic fisheries, most of the growth of the individual has been completed before it recruits to the main fishery, then it may be difficult to see much difference. For several demersal species, and others, there is a big range in size, and an examination of data over a period of years (e.g., from surveys) should show whether there has in fact been the change expected. If not, it may be that the larger fish have disappeared faster than expected, suggesting that the effort data has under-estimated the decline in abundance, and the effect of fishing. In any case examination of length data (and where available age-data) is a useful, but neglected, supplement to use of production models.

Many of the reasons for the relatively minor use of analytic models will continue to hold. Much of the basic information will remain scarce and it will be difficult to carry out single-species assessment for all the species, let alone attempt an analysis that takes account of the inter-specific effects. Nevertheless, there are ways that analytic models can and should be more widely used. In the absence of direct estimates, natural mortality for less well-studied species can be estimated by comparison with other stocks. For example, Pauly has derived the formula

$$\log M = 0.654 \log K - 0.28 \log L_\infty + 0.463 \log T$$

where K, L_∞ are the usual growth parameters, and T is the mean annual temperature. This, and similar approaches, can allow analytic models to be applied to many more stocks than would otherwise be possible.

The concepts of analytic models can also be used to answer specific questions even when a comprehensive assessment cannot be made. The most obvious case is in relation to possible changes in mesh size. Several techniques exist to evaluate the immediate and long-term effects of using larger meshes. Other than knowledge of the length-composition of the catches of each species the input data required is very little - a selection factor (which may be obtained, at least to a first approximation from looking at the shape of the fish), the current mesh size, and an estimate of the exploitation rate (e.g., the ratio of fishing to total mortality). Though the calculations are straightforward, few mesh assessments have been done for the IPFC region. Similar simplifications of the basic analytic approach can be used to answer other questions. The impact of offshore trawling on catches by inshore fishermen

could be assessed by identifying the main species that occur in the catches of both groups, determining the sizes taken in each group, and, using some estimate of interchange and exploitation rates in each fishery. The last steps might have to involve a range of assumptions, but if a range is used it would show how reliable the conclusions are, and where further studies are needed.

The main opportunities for new approaches to stock assessment lie outside single-species models. Many of the aspects of the assessment of multi-species fisheries, and of the relation of general ecological theory to fisheries, have been discussed at specialized meetings, some of which (e.g., the workshop organized by ICLARM in Cronulla in January 1981) have given particular attention to the problems of the IPFC region.

Some multi-species models are direct extensions of single species models. The mathematical difficulties of introducing for each species extra terms into the expressions for rate of increase (on the production models), or for growth and natural mortality (in analytic models) to allow for the interactions with other species are not great. However, as the number of species increase the number of parameters, and the difficulties of estimating them, become increasingly difficult, and ultimately in practical terms unsuperable. These types of multi-species models may be useful in northern waters (North Sea, Bering Sea) with a handful of species. As applied to those waters, they may also give some insight into the behaviour of multi-species stocks which can be helpful to the studies of tropical waters, even if they are not yet useful for direct application to waters with a very large number of species.

An important general conclusion of multi-species studies of temperate waters is that the greatest total yield (of all species combined) that can be taken, even under the best fishery strategy, is less than the sum of the greatest yield that can be taken from each of the individual species, if they are treated separately. The same presumably holds true for tropical waters.

Another extension of the production model approach, which looks at a multi-species community as a whole, e.g., by relating the c.p.u.e. of all species combined to total effort, has already been mentioned. The practical advantages of this approach, which gives results close to the form that administrators need, have been pointed out. If the abundance of all species changed in the same way there would be few theoretical objections, but this is not the case. In the Gulf of Thailand the analysis by Pauly (1979) of the survey data between 1966 and 1972 showed that some species had declined to less than 10% of their initial abundance, while others, notably squids, had increased. The changes have not been steady; Pope (1979) applied principal component analysis to the same data, and found, in addition to the first component of steady decline, a strong second principal component of an increase followed by a decrease. An interacting feature of both these analyses is that the differences between species are much the same in various areas of the Gulf of Thailand, and also in the surveys in the Andaman Sea off the Thai west coast. They therefore represent a real difference in the way different species react to fishing. Some of these differences can be accounted for by differences in direct impact of fishing on individual species - the longer-lived species, those more vulnerable to trawling (e.g., living close to the bottom), or occurring in areas of particularly intense fishing being likely to decline faster than short-lived species, those occurring, for at least some of the time well off the bottom or those living in less heavily fished areas. However, this cannot account for the increases that have occurred in some species (e.g., squid) or some of the other differences.

This paper is not the place to discuss how the interaction between species can be explained (by changes in predation or food supply, or by the impact on recruitment). The point that is relevant here is that the observations made do fit a fairly consistent pattern which is related to the important characteristics of the species - what does it eat, how does it behave, how big is it and how long does it live. Therefore it should be increasingly easy to predict how the species composition will react to increasing fishing pressure. For example, an increase in squid, comparable to that which has occurred in the Gulf of Thailand has been observed in several other parts of the world. As the first step this understanding can enable the scientist to give more detailed advice on the effects of changes in more detailed fishery strategy, i.e., of changing the balance of fishing pressure on different groups of species. For example, a consideration along these lines of the likely impact of a shift of emphasis away from the smaller sizes of fish could serve to strengthen or otherwise modify the conclusions reached on the basis of single specie models, that the use of a larger mesh size by the trawlers would be of long-term benefit.

By looking at similar systems (i.e., bodies of water of similar ecological characteristics) and seeing how they behave under exploitation, it could be possible also to improve quantitative predictions, e.g., of the potential yield, or of the number of vessels of a given type that can operate in a given area. Comparative approaches of this type have already proved extremely useful in fresh waters, where each lake can provide an independent observation. They have also been used in a modest way in the South China Sea, where estimates of potential yield, or initial biomass per unit area of demersal fish in the better studied areas of the Sunda Shelf have been used to provide first approximations for the other areas. It seems likely that this approach could be extended to some of the more detailed results needed by administrators. For example, the nature of the interaction between inshore and offshore stocks (and hence between the fisheries on these stocks) may be much the same in all tropical waters, or at least for waters with similar ecological characteristics. Comparative studies of different areas might therefore enable some useful insight into these interactions, and hence improve the advice that can be given about the increasingly serious problems of interaction between small-scale and industrial fisheries.

ANNEX 2

National Reports on Stock Assessment Studies

STATUS OF DEMERSAL FISH RESOURCES ASSESSMENT IN TROPICAL AUSTRALIAN WATERS

by

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1. BACKGROUND

Current exploitation of the demersal fish resources of northern Australia is by a Taiwanese fleet of pair trawlers operating under licence in the 200-mile Australian Fishing Zone (AFZ). This fishery began in the early 1970s, before the declaration of the AFZ, and has yielded between 12 000 t and 84 000 t annually. The exploited fish community is diverse, with about 800 species being so far recognized. A large proportion of these species are retained by the fishery.

Management advice concerns both the setting of catch quotas for the present Taiwanese operation and examination of possible Australian involvement in the fishery. These two questions are fundamentally different. The first concerns management of an existing, rather indiscriminant fishery for which a data base exists. The second requires accurate prediction of catch rates and species mixes under fishing regimes quite different to those applied in the past.

2. LISTING OF MAJOR RESOURCES

Regular assessments are being made for the Northwest Shelf (114°E-$123^{\circ}30'$E) and Arafura Sea (130°E-$136^{\circ}30'$E) regions. Assessment is made on the basis of yield characteristics for total fish biomass and the following species groups:

(a) *Nemipterus* spp.
(b) *Saurida* spp.
(c) *Lutjanus malabaricus*, *L. erythropterus*, *L. sebae*
(d) *Lutjanus lutjanus*, *L. russelli*, *L. vitta*
(e) *Lutjanus* spp.
(f) *Priacanthus* spp.
(g) Pomadasyidae
(h) *Carangoides* spp.
(i) *Epinephalus aureolatus*, *E. maculatus*, *Plectropoma maculatum*
(j) *Pristipomoides* spp.

A total allowable catch of fish biomass is set each year on the basis of these and other considerations. The optimal mesh size for the existing fishery has also been determined (Sainsbury, submitted). Assessments have also been made by Taiwanese scientists (e.g., Liu, Lai and Yeh, 1979), which indicate a considerably higher yield than those currently being employed (Sainsbury, 1979; Sainsbury and Okera, 1980; Sainsbury, submitted).

3. METHODS OF ANALYSIS AND DATA SOURCES

Data sources for assessment include historical Taiwanese catch and effort data by species groups (e.g., Liu, Lai and Yeh, 1979), commercial catch and effort data collected by the Australian Government from fishing operations in the AFZ since its declaration in September 1979, and biological studies made in conjunction with CSIRO research surveys.

Methodology employed for assessment of the existing fishery includes:

(a) use of Taiwanese commercial data in the early years of exploitation and swept area methods to estimate the virgin biomass (B_o), and estimation of yield from this, using Gulland's (1968) 1/2 MB approximation;

(b) fitting Schaefer's (1954) logistic stock-production model to the gross catch and effort data, with some allowance made for lack of equilibrium conditions;

(c) use of several Beverton and Holt (1957) type dynamic pool models in parallel, one for each of the above species groups, using parameter values from CSIRO studies in the area, the literature and derived from the historic catch data.

4. OBSTACLES TO ASSESSMENT

The problems encountered in providing reliable management advice for the northern Australian trawl fisheries are fully described in Sainsbury (1981, 1982). In particular, these problems include:

(a) the available historic data for the commercial fishery is of unknown reliability. This is exacerbated by the unavailability of pre-exploitation survey data collected by Soviet research vessels during the 1960s;

(b) in attempting to increase the reliability and utility of the catch-effort data base, severe practical difficulties are involved in obtaining species' specific fishery withdrawals information. These difficulties concern the high cost of fishery observer operations, the physical limitation of sampling on commercial vessels and the training of fisheries observers to perform accurate identifications;

(c) there is a dearth of information concerning the population dynamics and basic population parameters of most of the species being exploited;

(d) the theoretical framework for management of multispecies fisheries is exceedingly weak. Most methods being applied were derived to represent single species populations in low diversity communities, and the validity of their application to groups of species in highly diverse communities is unknown. This poses a particular problem to assessment of the likely viability of Australian involvement in the northern trawl fishery because such an assessment depends critically upon accurate prediction of catch rate and species composition under widely differing fishing regimes.

5. FUTURE ACTION

It is unlikely that a sound theoretical framework for management of tropical multispecies trawl fisheries will be available in the near future, and, if/when it is available, there is no guarantee that its data requirements will be simple. A likely requirement is a reliable time series of species' specific abundances and fishery withdrawals. To meet current management needs and simultaneously provide the best chance for development and application of improved methodology in the future, the following points are important:

(a) collection of reliable species' specific catch and effort data. This should include the discarded portion of the catch, and length frequency information for at least the major species;

(b) existing methodology should be applied cautiously, allowing large safety margins;

(c) if possible, a statistically sound trawl survey programme should be conducted parallel with the fishery to allow evaluation of changes in selectivity/catchability of the commercial fleet;

(d) studies should be initiated of the basic biology and population parameters of at least the major species. These studies should make full use of length frequency analysis, but, where possible, this should be supported by independent ageing data;

(e) wherever possible, new fishing methods or fisheries should be introduced in such a way that reliable empirical knowledge can be obtained of the effect of the introduction on catch rate and species composition. For example, if a fishery is being introduced or terminated, valuable data for the formulation and evaluation of later management options could be collected by introducing the change first in one geographical area, and using the remaining area(s) for comparison. An additional value in this approach is that it would allow evaluation of rotational harvesting as a management option (i.e., fishing different areas in rotation and allowing some recovery of the stocks before reapplication of exploitation). This mode of management could be of value in situations where the mode of exploitation greatly interferes with the regenerative powers of the resource (e.g., if trawling removes the habitat of some particularly desirable species).

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STATUS OF PELAGIC RESOURCE ASSESSMENT IN TROPICAL AUSTRALIAN WATERS

by

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1. BACKGROUND

The 200-mile Australian Fishing Zone (AFZ) placed the fish resources of a large region of the Indo-Pacific waters (see figure below) under Australian jurisdiction. These tropical waters include over one million km^2 of continental shelf waters, whose primary productivity levels are generally comparable to those of other tropical Indian Ocean and Indo-Pacific coastal waters. There are no obvious signs of major upwellings in the AFZ waters, and the fisheries potential of the region appears modest. The Great Barrier Reef along the tropical eastern coastline probably has an important influence on the aggregation of pelagic fish.

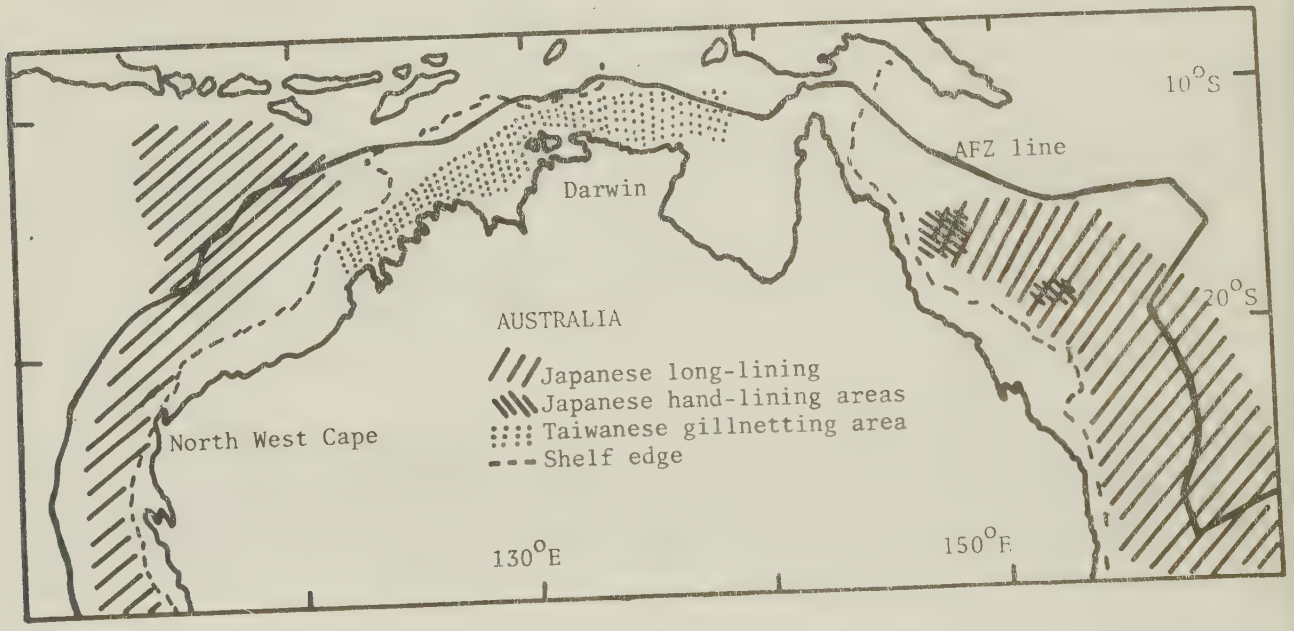
The smaller pelagic fish resource of the tropical AFZ shelf is unexploited, thus explaining the paucity of information on this resource. Of the larger pelagic species, three fisheries of distant-water fishing nations operate in the AFZ:

(i) Japanese hand-line fishery for deep-water pelagic species, predominantly yellowfin tuna;

(ii) Japanese long-line fishery, again for deep-water tuna species; and

(iii) Taiwanese gillnet fishery principally for sharks but also targeting for surface tuna and Spanish mackerel (Scomberomorus commerson) for preference.

The figure below shows the areas fished by these fleets.



2. MAJOR RESOURCES/FISHERIES	Assessments (regular/sporadic)	Remarks
Smaller pelagic fishes		
Anchovies - *Stolephorus* Sardines - *Herklotsichthys*, *Sardinella*, *Dussumieria* Scads and trevallies - *Decapterus*, *Selaroides*, *Alepes*, *Carangoides*, *Caranx*, *Selar*, *Megalaspis* Slipmouths or ponyfish - *Leiognathus*, *Secutor*, *Gazza* Indian or Club Mackerel - *Rastrelliger*	To date, few and general exploratory assessments have been made, visually during aerial surveys and by acoustic detection during ground surveys. Catch rates of these genera during 3 exploratory demersal trawls have been recorded.	There is no fishery for these groups of fishes in tropical Australian waters. Quantification is not possible and perhaps it is safe to say that probably the resource is average.
Larger pelagic species		
TUNA		
- Yellowfin (in Coral Sea and off north west Australia.	None; some catch rates and size composition probably available from Japanese data; 1980-81 catch ~ 3000 tonnes.	Japanese handline and longline fishery in the Coral Sea since 1965. Also long-lining off northwest Australia.
- Skipjack (all tropical waters)	Few intermittent aerial and ground surveys. Few exploratory fishing surveys along the tropical eastern and western coastlines. Author unaware of any catch statistics in present tropical pelagic fisheries of AFZ.	Good fishing areas are said to exist along tropical eastern Australia (see *Aust. Fish.* 39(2) for further information). Purse-seiner *Frontier* reported absence of fishable schools along western coastline and 1980 CSIRO aerial survey reported disappointing results. Small-scale fishing methods need to be tried out.
- Longtail tuna (northern waters)	None; exploited by Taiwanese gillnetters since 1974. Possible to obtain rough estimates of annual Taiwanese catch for the period 1974-1981.	Present Taiwanese catch of ~ 1000 tonnes.
- Mackerel tuna (northwestern and northern waters)	None known to occur in Taiwanese gillnet catches.	

Major resources/fisheries	Assessments (regular/sporadic)	Remarks
Other tuna (Big eye, Albacore, *Sarda*, *Auxis*, southern bluefin) and billfishes.	None for the first 4 species from tropical waters. Some information on southern bluefin stocks in temperate waters available (See Murphy & Sutherland, manuscript).	Catch statistics for bigeye, albacore and black marlin in Japanese longline fishery is available since 1975 (all waters?). Virtually nothing is known of the smaller coastal species *Sarda* and *Auxis*.
SPANISH MACKEREL (SEERFISH)		
- *Scomberomorus commerson*	None; taken by Taiwanese gillnetters and fished locally in Queensland. Total present annual catch ~ 1000 tonnes.	Catch figures in Taiwanese gillnetters available since 1976.
- Other spanish mackerel species (*S. queenslandicus*, *S. munroi*, *S. semifasciatus* etc.)	None; presently of uneconomic importance but quantities in inshore waters of ~ several thousand tonnes possible.	
SHARK		
- *Carcharhinus limbatus* and *Carcharhinus sorrah* (northern tropical waters)	None; principal species of the Taiwanese gillnetters; ~ 4000 and 6000 tonnes taken in 1980 and 1981	Catch figures, some length frequencies and biological data is becoming available.
- Other shark species of the genera *Sphyrna*, *Carcharhinus*, *Rhizoprionodon*, *Pristis*, etc.	None; secondary species in Taiwanese gillnetters.	Length frequencies and biological data becoming available through the Observer Programme.
Miscellaneous pelagic species (Barracuda, *Rachycentron*, manta rays, billfishes and marlin etc.	None; minor components in the Taiwanese gillnet fishery.	

3. DATA SOURCES AND METHODS OF ANALYSIS

It is probably safe to say that research on the assessment of the pelagic resources in tropical Australian waters has only just begun. Several years of intensive surveys, fisheries monitoring and biological studies are needed before forecasts of yield, stock size, etc., are possible.

For the smaller pelagic fish, during 1979-80, CSIRO's fisheries R/Vs COURAGEOUS and SOELA carried out six exploratory acoustic/trawl surveys off the northwest and northern Australian waters. One of the objectives of these surveys was to obtain information on the density and distribution of subsurface pelagic schools. Visual recordings of surface schools were also kept on these cruises. In June-July 1980, an aerial survey of the AFZ waters from Northwest Cape to Darwin was also undertaken by CSIRO to estimate the density and distribution of surface schooling pelagic fish. A summary of the findings of these surveys is given in Okera, Gunn and Jones (1981).

For the larger pelagic species, the Fisheries Division of the Department of Primary Industry (DPI) instituted from 1 November 1979 a system of data collection for the foreign fishing fleet in the AFZ. Details of this system are given in the Australian Fishing Zone Observer Manual, and the catch statistics (catch and effort) by species, in the case of tuna, are reported in DPI's monthly AFZ Bulletin. The database is stored in the CSIRONET computer and can be accessed on a CISRONET terminal anywhere in the country.

The Japanese fleet also keeps records of the sizes (dressed weight) of tuna caught by handlining and longlining. These data, if retrievable, will be useful in providing historical information on the length (age) composition of the exploited tuna species and for the computation of parameters for stock prediction models.

In the North the Taiwanese gillnet fishery takes sharks, Spanish mackerel and 2-3 species of smaller tuna, and gross catch and effort data are now becoming available (from November 1979). However, a more detailed data collection system at species level is needed. A start has been made on monitoring the catch and size composition of shark species.

Long-term programmes such as tagging and egg/larval surveys have not yet been attempted. The initial task has been to understand the resources/fisheries first, before undertaking such detailed and long-term studies.

4. OBSTACLES IN ASSESSMENT

4.1 Smaller Pelagic Species

(i) There is no fishery for these species and hence there is no way of forecasting yield based on past fishery performance.

(ii) Very little is known on the biology and ecology of these species in tropical Australian waters. Hence, abundance estimates based on such methods as egg/larval surveys in spawning areas during spawning seasons are difficult to apply.

(iii) Short life and recruitment fluctuations of these species make stock and yield predictions intricate if not impossible.

(iv) Several species presently of uneconomic importance (e.g., pony fish, leatherjackets) co-occur in large schools with potentially more useful species (*Dussumieria*, *Sardinella*, *Rastrelliger*, *Decapterus*, *Selaroides*, *Caranx*). Thus use of acoustic or primary production measurements could give misleading biomass estimates of these species.

(v) The problems inherent in acoustic estimation of stock size, and in the determination of population parameters of smaller pelagic species, have been well documented for the smaller pelagic fishes of the northern hemisphere. These difficulties are not enumerated here.

4.2 Larger Pelagic Species

(i) These are fished by distant-water fishing nations and accurate catch data (catch composition, effort, size composition) are only just becoming available to Australia for the Taiwanese gillnet fishery. For the Japanese longline fishery in tropical waters, I am informed that data are available since 1975. However, I am unaware of any assessment study based on these data.

(ii) Several species (e.g., skipjack, mackerel tuna, spotted Spanish mackerels) are virtually unexploited. Estimating the abundance of these by well-conducted surveys along a very long coastline is a long-term programme, requiring both money and staff dedication.

5. AVAILABILITY OF INFORMATION ON FISHERIES/FISH STOCKS

As there is no fishery for the stocks of smaller pelagic fishes, the only hope of obtaining any abundance estimates of economic importance is to have appropriate long-term surveys. The type of the survey has to be determined by clear objectives. For instance, if one wants to determine the catch rates of Sardinella, Decapterus, Rastrelliger and Dussumieria for the purposes of human consumption, surveys utilizing fishing methods which selectively fish for such species, are more appropriate than non-selective methods. On the other hand, if the mixed resource of small pelagics is to be utilized for fish meal, non-selective methods such as trawl surveys, utilizing appropriate vessel and gear size, will provide information on the likely magnitude of the catch.

Information on the larger tropical pelagic groups (tuna, mackerel, shark) and their fisheries is just beginning to become available through logbooks, radio reports and the Observer Programme. Monitoring the catches of what were 'high-seas' fisheries by the Observer Programme has a number of logistic problems and, in the long term, may prove difficult to execute and provide data of limited management value. Ideally, there should be a requirement, perhaps in AFZ fishing agreements, for the fishing boats to collect the basic data on catch and size composition. There is a need to make 'high-seas' fishermen aware of the importance of keeping accurate records of their catches, perhaps through educational programmes. The Japanese pelagic fisheries in the AFZ are already reporting catches by species. I am also informed that size composition by species data is also collected.

In the Taiwanese gillnet fishery, there is a long way yet to go before accurate catch and size composition data start to become available.

6. CONCLUDING REMARKS

With the exception of the tuna species taken by the Japanese fishing fleet, it is not possible to provide advice on yield estimates of other tropical pelagic fish species in the AFZ, given the information currently available. I am also of the opinion that innovative methods in stock assessment, drastically different in approach from those already known to fisheries science, are unlikely to emerge in the near future. Finally, the works of fisheries scientists on major exploited pelagic stocks have abundantly shown that even in regions where fishing statistics and knowledge of the exploited fish stocks are sufficiently known, mathematically or acoustically predicted yields often vary widely from the actual catches.

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BANGLADESH

by

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1. GENERAL

Bangladesh has a coast line of about 450 km and the economic zone extends to 200 mi seaward from the shore. The current marine production comes mostly from the artisanal sector although trawl fishing in the offshore areas have commenced in the recent years on a modest scale. Fishing activity and fish landings are extremely scattered and so far no built-in system for recording catches have been introduced. However, it is broadly estimated that the marine catch is about 0.12 million t and that 1 400 mechanized fishing boats and 10 000 non-mechanized boats are operating in the coastal areas. The offshore fishery is exploited by a small fleet of about twenty trawlers mostly concentrating on the marine shrimp resources. The Second Five-Year Development Plan envisages a total production level of 1.3 million t from marine and inland waters by 1984-85 and that the strength of coastal mechanized boats also will rise to 4 000. Although it is tentatively proposed to raise the offshore fleet strength this will be done progressively and will be based on improved estimates of potential yields, to avoid over-capitalization.

2. MARINE FISH STOCK SITUATION

2.1 Inshore/Estuarine Stocks

The inshore/estuarine fish stocks of Bangladesh include extensive stocks of pelagic species (predominantly Hilsa) and demersal species comprising of catfish, Bombay-duck, Indian salmon, etc., and shrimps (both Penaeid and Carid species). These stocks are exploited by the traditional inshore/marine fishery using stake nets, gillnets, etc., and provide the major portion of the present catch assigned to the marine sector.

Details of this fishery and species caught are given in Mohiuddin et al. (1980)-BOBP/REP/10.2-Vol.2 which includes complete bibliography for this section of the fishery.

Assessment of these stocks has not, however, been carried out, with the exception of a study of the estuarine stocks Hilsa ilisha. This species has been the subject of a recent study by Inland Fishery Consultant to FAO/BGD/72/016 Project. Details of the methods used and available information will be contained in the report being prepared by the Fishery Advisory Services Project, in collaboration with the Directorate of Fisheries.

The major obstacle to assessment of the estuarine/inshore marine fishery is the lack of catch and effort data for any continuous period of time. The logistic difficulties of collecting such data on a regular basis have yet to be overcome; however, the new system being initiated under the FAO/UNDP Fishery Advisory Services Project will be strengthened by the activities programmed under the Fishery Resources Survey System Project, to cover all resources.

2.2 Offshore Marine Stocks

2.2.1 Demersal fish and shrimps

Stocks of marine fish and shrimps are known to occur in Bangladesh waters. At present a small fleet of Government-owned trawlers (4-5 in number) are exploiting the fish stocks, and a fleet of about 20 shrimp trawlers are operating on the marine shrimp resource.

Various estimates of the standing stocks of fish and shrimps in Bangladesh waters, in the previous years, have been using survey data and "swept area" techniques. To date, data on the offshore trawl fishery has been limited to annual catch from the Government of

Bangladesh (BFDC) trawlers. However, with the assistance of the Marine Fishery Consultant of the FAO/UNDP Advisory Services Project, collection of all the available catch data have been initiated including that from the privately owned shrimp trawlers since 1978 when shrimp fishing began. A stock assessment based on this data and a review of stock assessment already made for this area will be contained in the forthcoming consultant's report. However, the indications are that stock size may be smaller than the one estimated earlier.

2.2.2 Offshore marine pelagic resources

A pelagic resource is known to exist and has been recently surveyed by the R/V DR FRIDTJOF NANSEN. The estimates of standing stock have been made from acoustic survey data and value ranges from 60 000 t to 120 000 t. However, since fishing of this offshore resource by national fleet has yet to begin, no data has been collected so far.

REVUE GENERALE DES PECHES DANS LES TERRITOIRES DE NOUVELLE-CALEDONIE, POLYNESIE FRANCAISE ET WALLIS ET FUTUNA

par

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Les pêches nationales dans les territoires de Nouvelle-Calédonie, de Polynésie Française et de Wallis et Futuna sont peu développées. Elles ne cherchent à satisfaire que les besoins des marchés intérieurs, relativement limités. Dans ces conditions, les principaux problèmes actuels sont l'évaluation de différents types de ressources et la mise en place des pêcheries (étude des techniques de pêche et des facteurs socio-économiques), lorsque des potentialités de développement apparaissent. A part quelques cas particuliers, les stocks ne sont donc que peu exploités et les besoins d'aménagement peu importants. Cependant, les données de biologie et d'écologie sont d'ores et déjà rassemblées dans l'objectif de faciliter les études futures d'aménagement des stocks.

1. RESSOURCES OCEANIQUES

Des prospections sont effectuées depuis quelques années pour évaluer les potentialités des différentes ZEE pour la pêche thonière. La principale méthode utilisée est la prospection aérienne consistant en la recherche des zones favorables à la présence des thons par radiométrie, puis au comptage et à l'estimation à vue des bancs. Ces observations directes sont complétées par des études générales sur la productivité des régions océaniques concernées

La ZEE de Nouvelle-Calédonie est probablement la région la plus intéressante. Des zones favorables (fronts thermiques) avec d'importantes concentrations de thons ont été trouvées. Des expériences de pêche à la senne ont été faites par des senneurs commerciaux, donnant des captures prometteuses. Cependant, des adaptations dans la méthode de pêche sont nécessaires. D'un autre côté, depuis quelques mois, des bateaux locaux et étrangers pêchent à la canne. Les résultats sont encourageants, cependant quelques difficultés sont possibles concernant l'approvisionnement en poissons d'appât.

En Polynésie, où il existe une petite pêcherie artisanale à la canne, les résultats apparaissent moins bons. Les thons sont concentrés dans une petite partie de la ZEE, se tenant en général près des côtes des îles. Par ailleurs, la productivité très basse de cette région du Pacifique ne laisse pas espérer une abondance élevée de poissons. Néanmoins, un développement notable de la pêche peut être envisagé. Les efforts actuels portent donc sur la mise en oeuvre de la pêche par des moyens appropriés. En particulier, les observations sur le comportement des bancs montrent que la pêche à la canne serait mieux adaptée, mais l'abondance très insuffisante des poissons d'appât pose un problème difficile.

De façon générale, le développement de la pêche thonière dans cette région du Pacifique est étroitement dépendant des solutions qui seront trouvées aux conditions locales, par exemple absence de thermocline, insuffisance des réserves en appât vivant, petite taille des bancs, mobilité et dispersion des poissons.

2. RESSOURCES COTIERES

Les régions côtières présentent deux caractéristiques principales qui, bien sûr, conditionnent la nature et l'abondance des stocks et par conséquent la pêche:

- elles appartiennent toutes à l'écosystème récifal;
- les influences continentales sont nulles ou négligeables.

2.1 Pêches démersales

Seules quelques espèces sont exploitées commercialement pour des besons particuliers. Il s'agit des huîtres nacrières, des trocas et des holoturies. Des études de dynamique des populations sont en cours pour ces stocks, parfois largement exploités.

Les poissons ne sont pas pêchés dans des buts commerciaux, sauf dans quelques lagons de Polynésie. Leur pêche pourrait être développée. Il faut cependant noter le problème majeur de la toxicité (ciguatera) qui peut exister soit chez certaines espèces, soit dans certaines zones.

D'autre part, des prospections ont été effectuées pour évaluer les stocks de poissons profonds. Des résultats encourageants ont été obtenus en Nouvelle-Calédonie et à Wallis et Futuna qui peuvent faire envisager le développement d'une petite pêche artisanale.

2.2 Pêches pélagiques

A part en Polynésie où des espèces de la famille des Carangidés sont exploitées une partie de l'année, les poissons pélagiques ne sont pas pêchés. Des prospections ont été faites pour les besoins de la pêche thonière. Les résultats montrent que les stocks de petits pélagiques sont très limités en Polynésie. Ils sont plus importants en Nouvelle-Calédonie où il a été trouvé que l'abondance est maximum pendant la saison chaude. Des études sont en cours pour obtenir une évaluation plus précise des ressources du lagon calédonien et pour déterminer les normes de gestion du stock.

RESOURCES AND ASSESSMENTS OF HONG KONG FISHERIES

by

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1. INTRODUCTION

The size and composition of the Hong Kong fishing fleet is shown in Table 1; of the 4 904 vessels in the fleet, about 94% are mechanized. In 1980, the fleet caught an estimated 186.7 thousand t valued at HK.$ 1 161.2 million. Of this total quantity, 86.2% was fish, 8.5% crustaceans and 5.3% molluscs. The total consumption of marine products during 1980 was estimated at 151.2 thousand t, of which 72.3% was from local supplies (total landings less exports).

2. RESOURCES AND FISHERIES

The resources and the methods by which they are exploited are summarized in Table 2. The major resource exploited by the fisheries is the mixed demersal fish of the northern shelf of the South China Sea and, to a lesser extent, the East China Sea (Figure 1). Exploitation is mainly by trawl (pair, stern and beam), longline and gillnet, of which pair and stern trawling are the most important. The estimated catches of fish by the various methods in 1980 are given in Table 3. The estimated total catch of fish has increased steadily over the last five years (Table 4, Figure 2), with most of the increase coming from the trawl sector. The increase in catch by the trawl fishery would appear to be a result of increases in the numbers of pair and stern trawlers, particularly the latter (Table 5). During the last five years there have also been major changes in the distribution of fishing activity by trawlers (Table 5), notably, a decrease in fishing activity in Area III (Figure 1) and a major increase in fishing by stern trawlers in the East China Sea. Associated with these changes were changes in the proportions of the landings from the different areas (Table 6). Exploitation of the mixed demersal resource is largely non-directed by species; however, certain degrees of selectivity do occur. Stern trawlers concentrate a proportion of their effort in areas known to yield good catches of pomfret (Stromateoides and Parastromateus spp.) and yellow croaker (Pseudsciaenea crocea), modern pair trawlers concentrate their effort in areas where squid are abundant in the late summer-autumn and longliners will select for certain species (e.g., golden thread, Nemipterus virgatus) by hook size and area.

Catches by pair trawl, stern trawl, longline and gillnet include reasonable quantities of species normally regarded as pelagic, these include scads (Decapterus spp.), Spanish mackerels (Scomberomorus spp.), hairtails (Trichiuris spp.) and sharks. The local landings (catch minus fishermen's consumption and landings in China) of these species are given in Table 7, together with the landings of squid which is the other major component of the offshore pelagic resource exploited by these methods. These fisheries primarily exploit the demersal resources of the shelf and pelagic species are mainly taken as a by-catch, the gear normally used (trawl, bottom longline and bottom gillnet) exploiting only that part of the stock that occurs close to the bottom. However, at certain times of the year, fishing effort may be specifically directed toward pelagic species. In January-March mackerels and hairtails may form up to 60 percent of the catch by gillnetters and at this time pelagic gillnets and pelagic longlines may be used. The catching of squid by modern pair trawlers in late summer-autumn is another case.

The shrimp fishery using beam trawls is the other major fishery, involving some 1.146 vessels which fish for shrimp in the inshore waters (less than 40 m) of the South China Coast from Hainan to Swatow. In 1980, landings by these vessels were estimated at 14.5 thousand t of crustaceans and 11.0 thousand t of fish.

3. ASSESSMENTS - DATA SOURCES AND ANALYSIS

3.1 Trawl Catch and Effort Programme

The trawler catch and effort sampling programme initiated in 1973 aims at a 10 percent sample of pair and stern trawlers landing at the two largest wholesale markets of the Fish Marketing Organization. This programme translates the fishing effort data obtained by interviews with fishermen onto $1/2^{o}$ longitude by $1/2^{o}$ latitude statistical rectangles; for example, the overall distribution of effort in different statistical areas in 1980 (see Figure 1) is given in Table 5. Data on the quantity and composition of the landed catch are obtained from the sales records of the Fish Marketing Organization and these data, together with the data on fishing effort, are used to estimate the catch per unit effort of the trawl fishery. These estimates provide indices of seasonal and annual abundance of major taxa for the purpose

f monitoring the level of exploitation of the stocks. Figure 2 shows the overall trends n catch per unit effort derived from the trawl sampling programme and the estimated total atch of the whole capture fishery and by the trawl fishery. The resource monitored by this rogramme is essentially the mixed demersal resource. Information on the relative abundance f the offshore pelagic species taken in the trawl fisheries is also available from this rogramme.

Additionally, the catch and effort statistics provide data for comparison of the fishing owers of the different types of trawlers. Regression analyses of the available data for ithin-year results yield correlation coefficients that are usually statistically insignificant. It is nevertheless possible to obtain estimates of the relative fishing powers using egression lines forced through the origin. Results from the data, expressed in terms of anded catch per fishing day, gave the relative power of stern trawlers as 0.32 (± 0.05) to pair of modern pair trawlers. Similar analyses using a product of trawl headline length nd vessel horsepower per fishing day (m/hp/day) as a measure of effort gave regression lines hose slopes were not significantly different from unity.

.2 Acoustic Surveys

A programme aimed at estimating the distribution and abundance of offshore pelagic fish pecies by means of acoustic surveys was initiated in 1977. Surveys were carried out in 1977 nd 1978 and the results of these surveys have been presented at the South China Sea evelopment and Coordinating Programme Workshop on Acoustic Methods for Resource Appraisal rveys, November 1979, Bangkok, Thailand. Reasonable concentrations of anchovies (Stolephorus pp.) were located to the south and west of Hong Kong during the spring survey (March-April, 977) but few traces of pelagic fish were located during the other surveys (June and November 977; March-April, May and September 1978). It is hoped to continue this programme in the ear future with the aim of surveying the northern continental shelf of the South China Sea etween the 50-m and 200-m contours throughout the year. The surveys use a zig-zag track ith approximately 30 n mi between the adjacent points, and information is collected continuously on a 24-hour basis using a Simrad Scientific Echo-Sounder EKS 38 and a Simrad QM-MK Echo Integrator supplied by the South China Sea Development and Coordinating Programme. no-integrator values are recorded at the end of each nautical mile. The mean integration alue (mm deflection per n mi) attributed to fish is calculated for each five miles of survey rack and these means are used to calculate 25-mile moving averages. The moving averages are lotted on charts and abundance distribution charts are drawn by contouring between chosen trata. An example is given in Figure 3. The mean integrator values are calculated for each tratum and converted to area back-scattering strengths. Experiments are being carried out sing caged live fish to obtain a value for the back-scattering strength of various species f pelagic fish found around Hong Kong to enable survey data to be expressed in biomass terms.

.3 Fishery Sector Surveys

Surveys are being carried out on various sectors of the Hong Kong fishing fleet to determine areas fished, catch and effort. These data collected monthly over a one-year period re obtained by interviewing vessel operators. A survey of the coral reef fishery was undertaken in 1977-78 and a survey of the shrimp trawl sector is currently underway (1981-82). hese surveys are primarily aimed at assessing fishery activity and, since they are not ongoing programmes and collect only limited information on catch composition, they are not used irectly for stock assessment purposes.

. OBSTACLES IN MAKING ASSESSMENTS

The major obstacle in making assessments is the difficulty in obtaining adequate information. The data required are often absent or unreliable. The major resource, the mixed emersal fish, is exploited by a number of countries for which catch and effort data are not vailable. Also this resource is exploited by a number of methods which are difficult to ompare and hence present difficulties in estimating total effort. The different gear also xploit the resource in different ways; this, and the tendency for effort to be directed pward particular taxa at certain times, gives variable effort on different taxa fished.

Data on catch composition for the trawl catch and effort programme are obtained for the records of the Fish Marketing Organization (FMO) and landings through FMO account for around 84 percent of the total pair and stern trawler landings, leaving a fairly large percentage for which catch composition is inadequately known. This also applies to sectors such as the shrimp trawl industry where landings are almost entirely outside FMO.

5. OTHER INFORMATION

Other information potentially available is the size composition of fish in the landings and independent estimates of catch per unit effort from research vessel catch data. To collect this information, however, would require long-term commitment of manpower and research vessel time that is not readily available.

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Table 1

Composition of the Hong Kong Fishing Fleet as at January 1979 (actual count) and October 1981 (estimate)

		1979		1981	
		Number	% of total	Number	% of total
Trawl	pair	356	6.6	291	6.1
	stern	447	8.2	375	7.8
	beam	1 296	23.9	1 112	23.2
	hang	75	1.4	75	1.6
	sub-total	2 174	40.1	1 853	38.7
Line	longline	633	11.6	547	11.4
	handline	541	10.0	477	10.0
	sub-total	1 174	21.6	1 024	21.4
Gillnet		1 220	22.5	1 094	22.9
Purse seine		298	5.5	240	5.0
Miscellaneous		562	10.3	575	12.0
TOTAL		5 428	100.0	4 786	100.0

Table 2

Hong Kong Fishery Resources and Fisheries

Resource	Fishery	Status
Mixed demersal fisheries	trawl	major
	longline	
	gillnet	
	beam trawl (by-catch)	
Shrimp	beam trawl	major
Pelagic inshore	purse seine	minor
	hang trawl	minor
Pelagic offshore	trawl (by-catch)	major
	gillnet (by-catch)	
	longline (by-catch)	
Coral reef	handline	minor
	longline	

Table 3

Estimated weight (thousand t) of fish caught by selected methods in 1980

Method	Weight caught	% of total
Pair trawl	56.9	35.3
Stern trawl	41.0	25.5
Beam trawl	11.0	6.8
Gillnet	21.8	13.5
Longline	13.3	8.2
Sub-total	144.0	89.3
Total (all methods)	161.0	100

Table 4

The estimated catch of fish from 1976 to 1980

	Catch in tons					Increase 1976-80
	1976	1977	1978	1979	1980	
Total catch	124 905	129 425	133 486	151 378	160 964	36 095
Trawl catch	73 900	81 122	91 328	100 740	108 883	34 983

Table 5

Changes in fishing activity by trawlers from 1975 to 1980

	Percentage effort distribution by areas							Number of[a/] vessels
1975	I	II	III	IV	V	VI	East China Sea	1976
Stern trawl	8.1	21.9	19.3	25.7	12.6	4.1	8.2	160
Modern pair trawl	13.8	15.2	18.5	45.0	7.5	0.04	-	114
Junk pair	-	9.8	6.4	79.3	4.5	-	-	231
1980								
Stern trawl	5.7	9.0	2.3	7.3	2.8	9.0	63.9	447
Modern pair trawl	11.0	23.0	7.4	44.4	14.2	-	-	231
Junk pair trawl	-	78.6	-	21.4	-	-	-	125

a/ Actual counts

Table 6

Percentage of local landings of fish from different areas by trawlers at Aberdeen and Cheung Sha Wan markets in 1975 and 1980

	Percentage local landings (t) by areas						
1975	I	II	III	IV	V	VI	VII
Stern trawl	13.0	23.5	29.9	17.8	7.9	2.4	5.4
Modern pair trawl	13.7	14.9	19.0	46.5	5.8	0.04	-
Junk pair trawl	-	17.4	7.9	69.1	5.6	-	-
1980							
Stern trawl	8.7	7.9	3.1	6.8	1.9	9.9	61.6
Modern pair trawl	8.9	23.3	6.5	48.1	13.2	-	-
Junk pair trawl	-	78.6	-	21.4	-	-	-

Table 7

Local landings (t) of selected pelagic fish and squid, 1980

Species	Weight landed	% of total
Scads	9 168	8.2
Mackerels	2 136	1.9
Hairtails	2 383	2.1
Sharks	1 450	1.3
Squid	4 104	3.7
Sub-total	19 241	17.2
Total landings (all fish & squid)	111 295	100

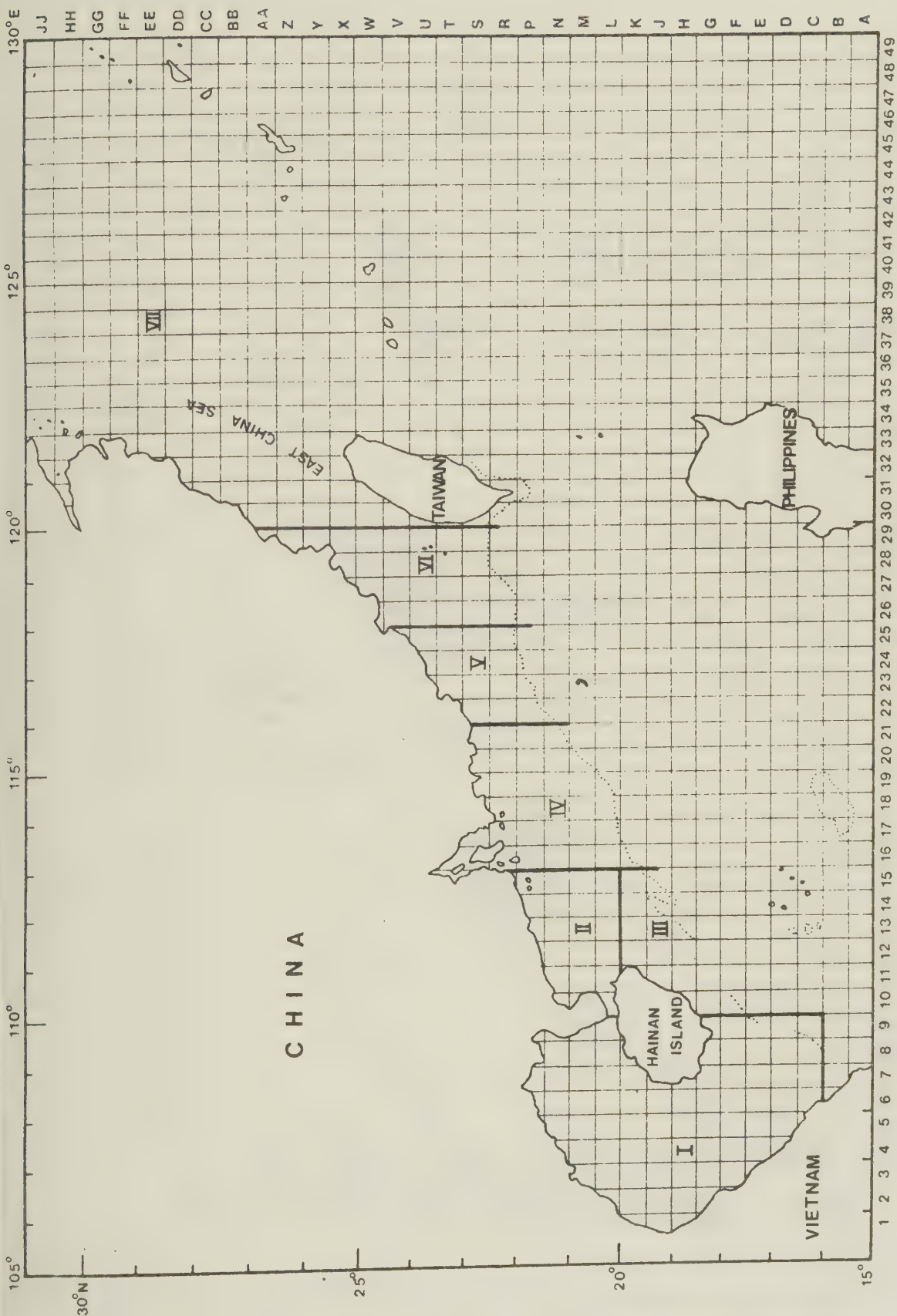

Figure 1. Hong Kong fisheries statistical areas

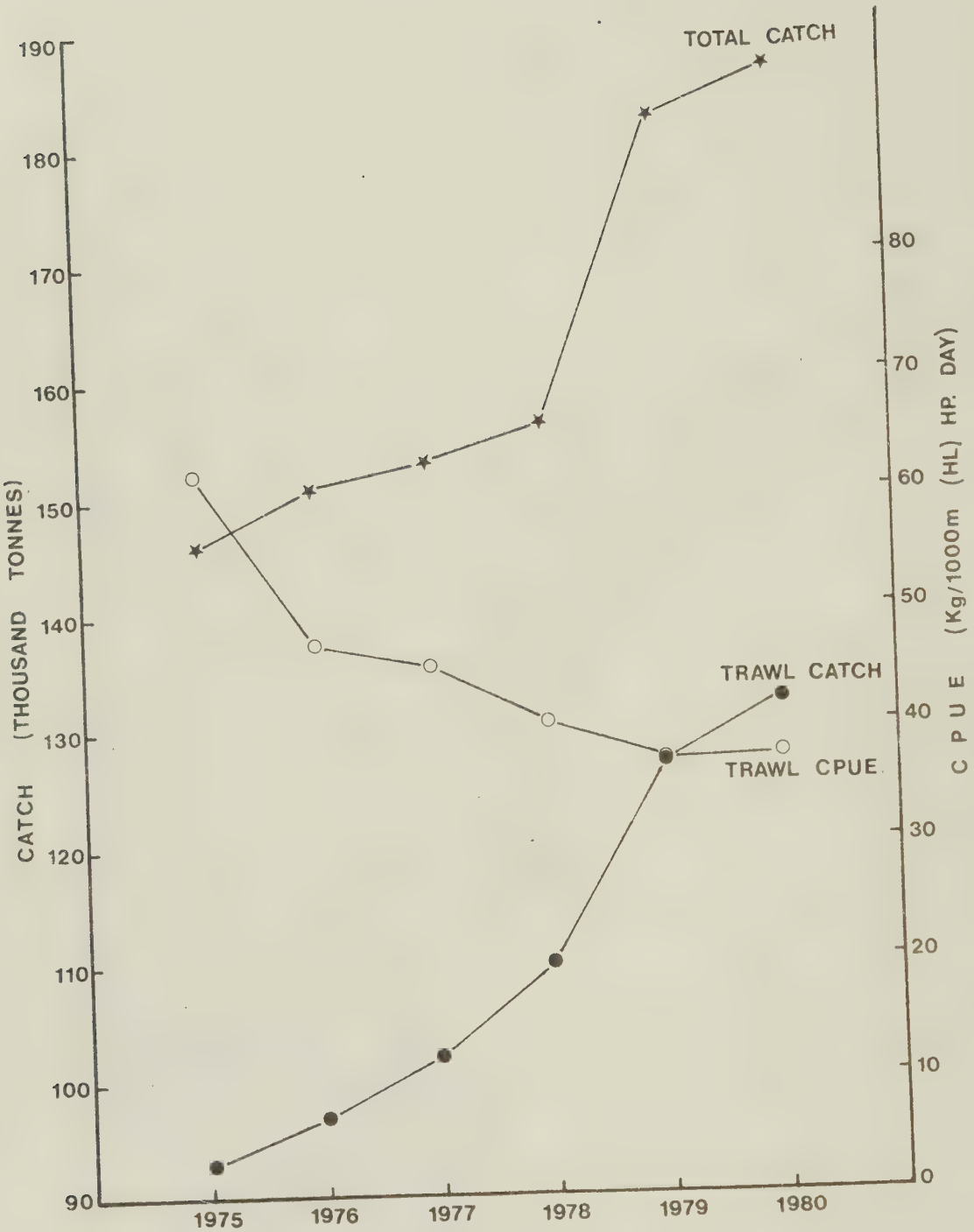

Figure 2. Catch and catch per unit effort for the trawl fishery and the total catch by all methods

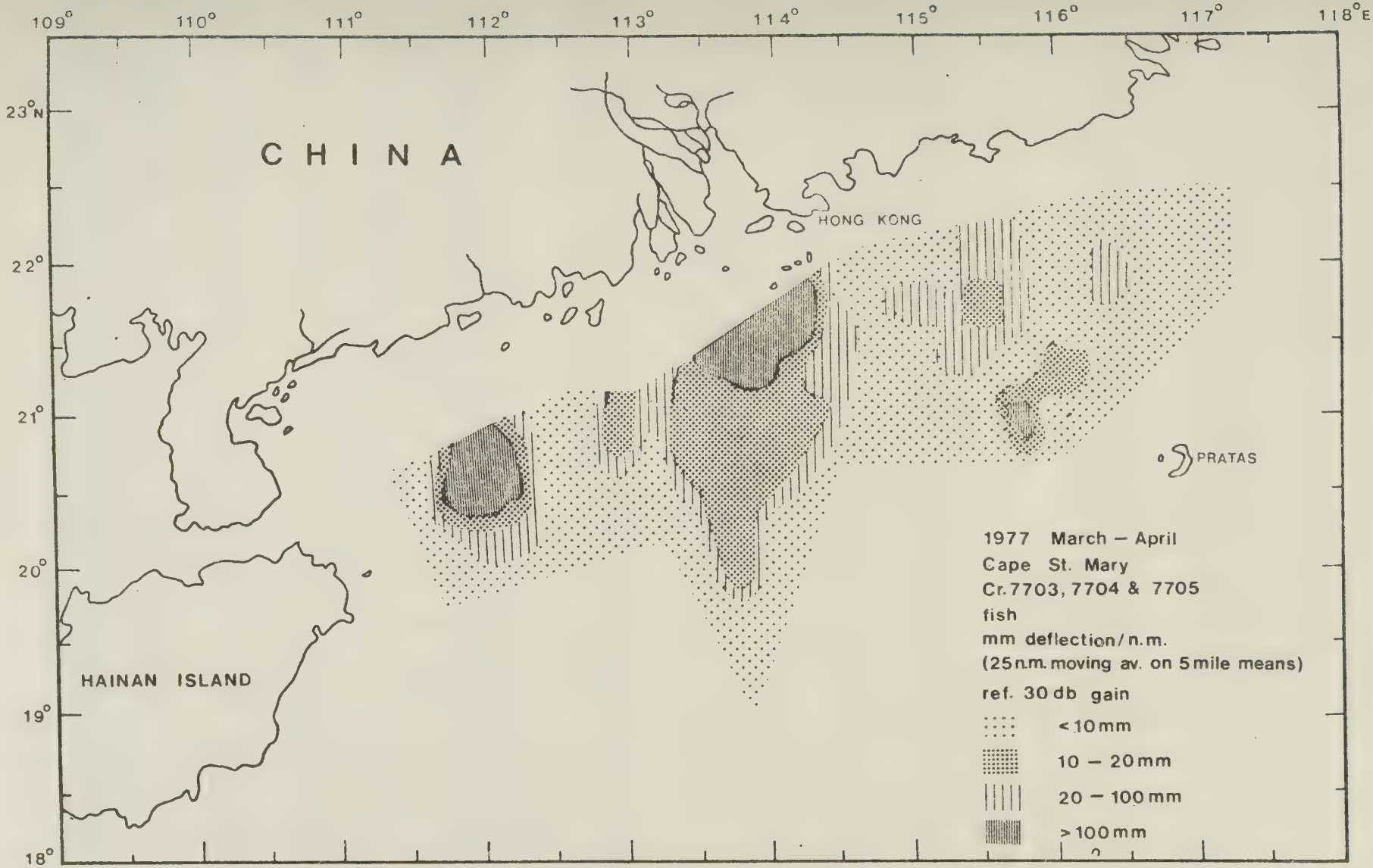

Figure 3. Distribution and abundance of fish echoes

ASSESSMENT OF INDONESIAN FISHERIES

by

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1. ASSESSMENT OF EXISTING FISHERIES

The main method used to assess existing fisheries has been the production model, based on catch and effort statistics.

Improved fishery statistics have become available since 1975 and have been used in these assessments with data covering all catches by species landed by each type of fishing gear and by each defined coastal area. However, there are still some unreliable data which made a satisfactory assessment of the present state of the stocks difficult. The number of gear or vessels actually operated is not well known and in many cases part of landings (sometimes remarkably high) are classified as miscellaneous. In spite of these constraints to make the best use of the available data, a simple regression analysis of catch per effort against total effort has been made to obtain a general idea of the state of exploitation of the resources in each coastal area.

To estimate the total effort for demersal fish and shrimp, trawls have been used as the standard gear, and purse seines for pelagic fish. The effort of other types of gear have been converted to the standard using the ratio of the average catch per unit effort of the two gear.

The results of these analyses are given in Table 1. This shows that most of the coastal areas available to the small-scale fisheries using traditional gear are overexploited. Opportunities for some further expansion exist in offshore waters, especially for pelagic fish.

1.1 Oil Sardine in the Bali Strait

After the introduction of purse seining in 1973, the sardine fishery in Bali Strait developed rapidly and the need for managing the fishery was felt both by the two provinces of East Java and Bali. This fishery, on Sardinella longiceps, has therefore attracted special research attention, involving the collection of catch and effort statistics, biological sampling and acoustic surveys. In 1977, based on catch-effort-data analysis and acoustic surveys, a maximum effort of 150 units of local purse seiners was defined and licences for purse seining were distributed among the coastal areas facing Bali Strait.

The number of fishing units increased from 193 units in 1977 to 237 units in 1980, including unlicensed units.

Using the landing data of 1974-80, another assessment was conducted in 1982 which gave an MSY of 36 000 t with related effort of 190 units, i.e., rather less than the actual number now operating.

Evidence of heavy fishing is given also by the acoustic surveys and length data. An acoustic survey with the R/V TENGGIRI (39 m) in early 1980, employing the latest Simrad acoustic sounder, gave an estimate of pelagic fish biomass of 45 000-49 000 t. Catches of 36 000 t would correspond to a fishing mortality of 0.8-1.0. Length frequencies of the landings are continuously monitored and the mean length has clearly decreased from 17.0 cm in 1978 to 16.5 cm in 1979 and 15.5 cm in 1980.

1.2 Tuna and Skipjack

These species are receiving special attention because of their high values and apparent potential for increased production. At present pole and line fishing using live bait is done mostly in the eastern waters of Indonesia, but modernized small-scale fisheries - trolling, gillnetting or seining - are also developing off West Sumatra, and south of Java and Bali. Detailed catch and effort statistics are being collected from these fisheries.

Routine size-composition data are also collected at the major landing places. This is part of a common programme between Indonesia and the Philippines to determine growth, mortality and migration patterns. Technicians recruited from local fishery services are trained and assigned both on the data collection, including daily and monthly landings, and measurements of fishes.

1.3 Shrimp

After the banning of trawling in Sumatra and Java late in 1980, monitoring of landings of shrimp with other fishing gear is carried out in both areas. Socio-economic studies concerning the transfer from trawling to other fishing methods, condition of fishermen involved and market/export evaluation for the coming years are also being made.

Stock assessment of shrimp stocks in the Arafura Sea is still continued by computerizing data catches and effort obtained from logbooks distributed to the shrimp fleet.

2. UNEXPLOITED STOCKS

For unexploited or little exploited stocks, a number of surveys have been made. The methods used have varied with the area, and the type of resource being surveyed. For small pelagic fish emphasis is being given to acoustic methods.

2.1 The South China Sea and the Sulawesi Sea

The Indonesian Fishery Development Programme is a technical assistance project from the Canadian Government to Indonesia with the main areas for development in the South China Sea and the Sulawesi Sea. One of the project activities include resource surveys leading to establishing feasible pilot projects for both areas.

Two research vessels operated and financed by the Indonesian Government are joining the project. These are the R/V TENGGIRI, a 39-m purse seiner and the R/V BAWAL PUTIH I, a 27-m stern trawler. Both vessels are equipped with Simrad scientific sounders. Two major acoustic surveys have been carried out in the South China Sea for four months in 1981. An acoustic survey is being conducted in the Sangibe waters, Sulawesi Sea, which will be concluded in May 1982.

2.2 The Central Sulawesi Waters

The R/V BAWAL PUTIH I made two 2-month acoustic surveys in central Sulawesi waters in 1979 and in 1980. These covered the deep waters to west and east central Sulawesi where the fisheries is least developed.

A workshop to disucss the results was held at the Research Institute for Marine Fisheries Research in Jakarta between scientists involved with the surveys and planning authorities from the central Sulawesi province. The outcome suggests that the eastern waters of this province offer greater potential for development in the near future.

2.3 The Indian Ocean

A joint survey between the Indonesian, German and Australian Governments to identify potential stocks available along the Indonesian coastal waters bordering the Indian Ocean was carried out between the beginning of 1979 and September 1981. The work was carried out

Table 1

Summary assessments of the state of selected Indonesian resources

Area/stock	Catches (in t) MSY	Catches (in t) 1979	Effort (number of trawlers) MSY	Effort (number of trawlers) 1979	State of exploitation
Malacca Strait					
Shrimp	18 000	16 091	1 770	1 969	Overexploited
Demersal fish	137 000	86 168	1 758	2 571	Overexploited
Shrimp and fish	167 000	154 024	2 092	2 571	Overexploited
East coast of Sumatra					
Demersal fish and shrimp	28 000	29 692	276	220	Fully exploited
North coast of Java					
Demersal fish	114 000	105 577	1 338	1 642.7	Overexploited
Shrimp	6 900	1 790	116	1 684	Overexploited
Demersal fish and shrimp	124 000	116 894	1 370	1 642	Overexploited near shore
Pelagic fish (a)	290 000	185 000	5 500	2 171.9	Developing
Southwest Kulimantan					
Demersal fish	35 000	37 174	1 640	1 708.8	Fully exploited in coastal area
West coast of Sumatra					
Demersal fish and shrimp	23 000	24 395	287	269	Fully exploited
Shrimp	1 500	1 278	209	288.4	Fully exploited
South coast of Java					
Shrimp (b)	5 700	4 907.8	1 271(106)	1 886(157)	Overexploited
Bali - Nusa Tenggara Timur					
Pelagic fish (a)	48 000	48 671	494	464	Fully exploited
South Sulawesi					
Demersal fish	34 000	46 265	187	202.6	Overexploited in near-shore area
Pelagic fish	115 000	132 517	1 970	1 910	Fully exploited
Flying fish roe (c)	135	71.4	2 800	2 082	Fully exploited (fishery fluctuates)
Moluccas					
Demersal fish and shrimp	18 000	16 598	340	207	Developing
Shrimp	5 200	5 122	52	165	Fully exploited
Pelagic (b)	27 000	25 833	1 650	1 268	Developing
West Irian					
Demersal fish and shrimp	4 700	7 203	50	74.4	Fully exploited

NOTES: (a) Effort expressed as number of standard purse seiners
(b) Effort expressed also as number of specialized shrimp trawlers (in brackets)
(c) Effort expressed as number of trips

in two modules: Module 1 (Indonesia) covered the areas stretching from south of Bali to Timor; Module 2 (Federal Republic of Germany) has been assigned to cover the waters from south of Bali to West Sumatra. For Module 1 R/V BAWAL PUTIH II (33-m) was used and for Module 2 the R/V JURONG from the FAO vessel pool was chartered by the Government of the Federal Republic of Germany. Data obtained from the two vessels are being analysed at the Agency of Agricultural Research and Development Computer Center in Jakarta.

The publication of a field guide to identify the fish species is being planned, while specimens collected and identified will be part of the existing reference collection in Jakarta.

SURVEY ON THE FISHERIES RESOURCES AROUND JAPAN

by

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Since the establishment of the 200-mile Exclusive Economic Zone around Japan, the Government has initiated an extensive survey on fisheries resources in her territorial waters in order to assess the magnitude of resources and to determine allowable catch for each fish species. The survey is carried out by the Fisheries Agency in cooperation with Prefectural Fisheries Experimental Stations since 1977.

1. OUTLINE OF SURVEY

Statistical and biological surveys are conducted continuously on all fish species including those which are unexploited and discarded; at the same time, existing knowledge of fisheries resources is also reviewed.

1.1 Statistical Survey

Catch and effort statistics by the type of fishing, fishing ground and season are compiled mainly based on fishing record sheets which are submitted from the fishing boats to the authorities concerned. According to the fisheries regulations in Japan, major fisheries are obliged to submit fishing record sheets to the authority, while for the small-scale fisheries there is no obligation to do so. Therefore, a sample of fishing boats belonging to minor fisheries is selected and requested to submit fishing record sheets in order to make the survey complete.

After the contents of fishing record sheets are checked by the authorities, they are sent to the responsible National Fisheries Research Laboratory according to the type of fisheries or fish species. These fishing record sheets have been collected from 28 types of fishing classified by the scale and area of operation, i.e., 6 trawlings, 5 purse seinings (including surrounding net), stick-held dip net, 2 anglings, 8 gillnets, 5 longlines and trap nets. However, difficulties are experienced in collecting fishing record sheets from some areas and several types of fishing.

1.2 Biological Survey

Regular survey is carried out on the following fish species: herring, sardine, anchovy, lizardfish, argentine, saury, mackerel, swordfish, jack mackerel, yellowtail, seabream, tilefish, sand eel, ocean perch, puffer, flatfish, sandfish, greenling, Alaska pollack, cod, squid and tanner crab. Size and weight are measured for sufficient number of fish at 82 fish markets at regular intervals. Gonads, scales and otoliths are also sampled for further examinations.

Other species which are not exploited, discarded or locally important are investigated from time to time. The data are gathered to the responsible National Fisheries Research Laboratory.

2. PROCESSING OF THE DATA

Data processing and stock assessment are carried out by the two working groups which are organized by the responsible National Fisheries Research Laboratory. One group is in charge of fish species of widely distributed pelagic resources, and the other is responsible to demersal fish communities in a region. The working groups have developed 26 computer programmes for the sake of scientific calculation and stock assessment. Every working group holds a meeting once a year to discuss the results with scientific staff participating in the survey.

Stock assessment for some species has not been done enough due to the lack of information for some areas and periods.

3. OTHER SURVEYS

Experimental fishing around Japan with commercial boats is carrying out to develop new fishing ground. A hydroacoustic survey of fisheries resources with so-called scientific echo fish-finder is also conducted. Although there are many technical as well as biological problems to be overcome, this type of survey is generalizing in the fisheries resources survey.

Estimation of stock size by the number of eggs spawned in the sea has been made for sardine and mackerel along the Pacific coast. The estimation is based on quantitative survey of floating eggs throughout the spawning season and area, and biological information of spawner. The total number of eggs spawned can be calculated from average number of egg per unit area, mean duration of embryonal development, mean survival rate during egg stage, range of spawning area and duration of spawning season. Biological information is collected for the age composition of spawner, sex ratio, fecundity by age, average body length and weight for each age group. Survival rate from egg to first spawning age is also investigated. Using this information, biomass of each age group can be calculated by either number or weight

ASSESSMENT OF MALAYSIAN FISHERIES RESOURCES

by

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Commercial fish landings in Malaysia are derived from the catches by various fishing gear operating in coastal waters. Both demersal and pelagic fisheries resources are exploited by these fishing gear. The main fishing gear presently responsible for the bulk of marine fish landed, in order of importance, are:

(a) trawl nets,

(b) seine nets, and

(c) drift gillnets.

Apart from the above, other less important fishing gear in operation include hooks and lines, bagnets, traps and lift nets.

1. TRAWL FISHERY

The bulk of the demersal fish and prawn stocks are exploited by trawlers which operate otter trawls, the only type of trawl currently in use. Trawlers contribute about 45 percent of the total marine fish and prawn landed in Peninsular Malaysia in 1980. There are at present some 6 000 trawl units estimated in operation in Peninsular Malaysia, the majority (67%) being small units of below 25 gross tons. Catches landed by the trawlers include a very large number of demersal fish species, none of which is individually very abundant. Some of the more common families landed are the Nemipteridae, Sciaenidae and Cynoglossidae. In addition to these, the higher priced demersal fish species landed include those from the families Serranidae and Lutjanidae. The landings of commercial trawlers also include a substantial amount of prawns. Approximately 50 percent of the total prawn landings in the country is attributed to the landings by trawlers. The commercially important prawn species include Penaeus merguiensis, Penaeus monodon, Metapenaeus affinis, Metapenaeus brevicornis, Metapenaeus lysianassa, Parapenaeopsis coromandelica and Parapenaeopsis hardwickii. The most important genus commercially is Metapenaeus due to its abundant occurrence in commercial catches, while the genus Peaneus, although not abundand, commands a high price by virtue of its meat quality and size.

2. SEINE FISHERY

The seine fishery rank next in importance to the trawl fishery in the country. Various types of seines are employed in this fishery, the most important commercially being the purse seines which account for about 35 percent of the total marine fish landings in Peninsular Malaysia in 1980. Currently, there are some 2 500 seine units in operation and the bulk of the pelagic stocks are fished mainly by these seines. However, purse seines constitute only about 33 percent of the total seine units in operation, although they contribute around 90 percent to the total seine landings.

Catches landed by the purse seines include only a few pelagic fish species, the more abundant ones of which are Rastrelliger spp., Stolephorus spp., Decapterus spp., Sardinella spp. and Megalaspis cordyla.

3. DRIFT GILLNET FISHERY

Currently there are some 10 000 gillnet units estimated in operation in Peninsular Malaysia, the most prominent among them being the drift gillnet which is the most extensively used throughout the country. While the number of gillnet units in operation is much bigger than either trawlers or seines, they contribute only about eight percent of the total marine fish landings in the country in 1980. The main fish species landed by the drift gillnet include Scomberomorus spp., Rastrelliger spp., Euthynnus spp./Thunnus spp. and Chirocentrus dorab.

Of the three major types of fisheries described above, only two types are of major concern to the national fisheries administrators viz. the trawl fishery and seine fishery (in particular, the purse seine fishery) which exploit the bulk of the demersal and pelagic resources, respectively. Consequently, advice is frequently sought by the fisheries administrators on the potential and state of these resources for the formulation of policies for the development and management of the two fisheries. Reports on the results of monitoring trawl surveys on the state of the coastal demersal fish resources as well as other studies and assessments of the demersal and pelagic resources have been submitted regularly to the fisheries administrators. A number of such reports have also been published in the national Fisheries Bulletin and Malaysian Agricultural Journal. In addition, assessments of the national demersal and pelagic fish resources have also been made in the course of several workshops organized and sponsored by the FAO South China Sea Fisheries Development and Coordinating Programme, the results of which have already been published in their various workshop reports.

Systematic trawl surveys have been carried out with research vessels in the coastal waters of Malaysia by the Fisheries Research Institute, Fisheries Division, Ministry of Agriculture, to assess and monitor the abundance/state of the coastal demersal fish and prawn resources. Stock densities and estimations of biomass have been computed from the results of these trawl surveys using the "Swept-Area" method.

In addition to these demersal trawl surveys mentioned above, estimates of optimum yields have also been made from commercial catch and effort data, employing simple logistic-type production models (linear logistic as well as exponential logistic models), for both demersal and pelagic fisheries.

An acoustic pelagic survey programme has also been initiated with the technical assistance of FAO under its Technical Cooperation Programme to assess the pelagic fish stocks off the East Coast of Peninsular Malaysia, beginning in October 1980 until April 1982.

The various assessments of the demersal and pelagic fish stocks utilizing the above-mentioned methods with currently available data are at best very rough estimates only. Numerous assumptions had to be incorporated in the analyses, e.g., escapement of fish from the trawl in the Swept-Area method, and simple logistic curve to describe a whole assemblage of fish species that make up the demersal fish stock in the area. In addition, the necessary data base for more realistic estimates of optimal yields and effort for the demersal and pelagic fisheries need to be further improved and enlarged, particularly catch and effort data of commercial trawlers and purse-seine boats. While the simple total biomass Schaefer-type production model appears to be applicable to the fisheries for quick and rough estimations of yield, the data base necessary for the simple model that is currently available still lacks details, particularly in relation to the commercial effort statistics. However, there has been some recent improvement to catch and effort statistics collection by the Statistics Section of the Fisheries Division and it is hoped that these improvements would enable refinements to be made in the employment of logistic production models for estimations of yield.

Another major constraint is the lack of trained staff currently available to carry out stock assessment work in the country. Although all national fisheries research scientists recruited by the Government possess a first degree in biological sciences from universities, only a minority of them receive some form of training related to fisheries in general during their first degree course in the universities. Thus specialization in fisheries science would only be acquired by these officers through the course of their work. This has posed a major constraint in the national fisheries research programmes, particularly in fisheries resource assessment as the majority of the current research officers are relatively new in service and thus lack the necessary training to tackle fisheries research and resource management problems.

STOCK ASSESSMENT OF NEW ZEALAND MARINE FISHERIES

by

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1. INTRODUCTION

New Zealand's marine fisheries exploit a diverse range of species, and, with a few exceptions, fisheries research has not been directed at a single species or fishery for long periods of time. Traditionally New Zealand's fishermen have worked inshore areas with catches of about 40 000 t of finfish and 15 000 t of shellfish. More recently the deeper waters (200–1 200 m) in the New Zealand Exclusive Economic Zone (EEZ) have been exploited, at first by foreign fishing vessels, and later also by joint venture and New Zealand-owned vessels. These latter fisheries have included deep-water trawling, bottom longlining, jigging and trawling for squid (Nototodarus spp.), tuna longlining and purse seining for skipja

2. DATA SOURCES

There is a strong interdependence between the types of data collected and the methods of assessment used. Obviously the data that are available determine what analyses can be performed. Ideally, the data collected for a fishery should be determined by the types of analyses that are thought appropriate. In practice, the types of data collected are subject to constraints such as the reluctance of fishermen to provide detailed information on their activities, the availability of aging techniques, or the costs of collecting data.

One of the primary sources of stock assessment data in New Zealand is commercial fisheries statistics. Statistics for the New Zealand domestic fisheries have for many years been based on monthly records of catch and effort supplied by fishermen. For the years 1961-74, data are available from a computer system which compiles catch, days at sea, fishing area and fishing method.

This system worked relatively effectively but did not provide adequate information on fishing effort and location. In 1974 the system was changed with a view of improvement. However, the new system proved to be complicated for fishermen and was not followed up by the necessary data processing facilities. As a result, substantially less information on fishing effort and area was obtained for inshore finfish. This calamity is only now being remedied.

Foreign vessels have fished the New Zealand area since the 1950s. However, apart from summaries of the Japanese efforts during the 1970s, data from their operations were not available on a systematic basis until New Zealand asserted jurisdiction over its 200-mile EEZ in 1978. Since then, detailed catch and effort data have been collected using a logbook system. Much of the deep-water trawl catch is processed before it is weighed and whole weights are estimated or calculated using conversion factors. In either case, it is unlikely that these data are accurate to any more than two significant digits.

Research cruises are the second major source of data for stock assessment. Commercial types of fishing gear are often used on these cruises and their catch per unit effort data can be used to complement those from commercial vessels. Such cruise data are few, but are useful in two ways. Firstly, research cruises can provide standard catch rates from the same vessel and gear over long-time periods giving estimates of changes in abundance (James, 1980), and, secondly, they can be used to carry out controlled surveys of populations (Allen and Cranfield, 1979). The use of research vessel catch and effort data avoids the two worst problems of commercial catch and effort data; the need to standardize effort and to compensate for the aimed fishing of commercial fleets.

As well as providing catch rate data, research cruises have been used regularly for obtaining life history information (for example: size, age and sex compositions), and substantial amounts of these data are available for the most important inshore species.

Research cruises have also been used for a variety of other purposes such as plankton surveys and tagging experiments. Acoustic techniques have been developed and are about to be used on research cruises.

For several techniques of stock assessment the age composition of either the population (mortality estimates) or the catch (cohort analysis) is a necessary data item. Some age and size composition data are available from research cruises, but, in addition, there have been several attempts to collect size or age composition data from commercial catches on a regular basis. The two most notable attempts are the catch sampling programme (Allen, 1975) which collected length frequency as well as other data from fishing boats at sea during the period 1966-73, and a market sampling scheme which was intended to replace the catch sampling programme in 1974 but which was never properly established (West, Ms).

Aerial surveys have been carried out regularly since 1976 to assess the availability of pelagic fish (Habib, Clement and Fisher, 1981). The surveys were carried out principally in support of commercial fishing operations, and, consequently, the data are not ideal for stock assessment purposes. However, because of the behaviour of large bodies of skipjack, it has been possible to use these data to estimate the biomass of skipjack in New Zealand waters during some years (Habib, Clement and Fisher, 1980).

3. STOCK ASSESSMENT METHODS

For convenience, I shall group stock assessment methods into three categories: biomass estimates, sustained yield estimates and assessments of the dynamics of populations.

Biomass estimates (including those in which a sustained yield is estimated as some fraction, say 10 percent, of the biomass) are generally the simplest form of assessments. These are the only types of estimates that have been made for the deep-water species and are also the most common for inshore species.

Several assessments have been made of the biomass of deep-water stocks using catch rate data from a combination of research survey cruises and commercial fishing operations (Francis and Fisher, 1979; Francis, 1981; Patchell, 1981). These estimates were made using assumptions about catchability and about the relative abundance of fish in areas trawled compared to the total area, and are thus not very accurate. In addition, it has been difficult to obtain enough data to get a high level of precision. For example, Patchell (1981) gives upper and lower bounds for an estimate of the biomass of the Westland hake population of 20 000 t and 60 000 t based on sampling variability and alternative values of catchability. The agreement among Francis and Fisher (1979), Francis (1981), and Japanese and Soviet workers is about at the level of an order of magnitude. Species for which biomass estimates have been made on the basis of catch rates include southern blue whiting (Micromesistius australia), hoki (Macruronus novaezelandiae), hake (Merluccius australis), ling (Genypterus blacodes), silver warehou (Seriolella punctata), jack mackerel (Trachurus spp.) and squid.

The results of egg surveys have been used as the basis for estimates of the spawning biomass of populations of sprat, Sprattus antipodum (Colman, 1979) and snapper, Chrysophrys auratus (Crossland, 1980a). This method is currently being used to provide biomass estimates for hoki and hake.

Mark recapture methods have been used to make population size estimates for snapper (Crossland, 1980b), dredge oysters, Tiostrea lutaria (Cranfield and Allen, 1979) and have been used in conjunction with aerial surveys for making estimates of trevally, Caranx georgianus, populations (James and Ryan, Ms). Aerial surveys have also been used for making estimates of lower bounds for the biomass of skipjack migrating through New Zealand waters (Habib, Clement and Fisher, 1980).

Sustained yield estimates are normally made on the basis of either production models which relate biomass changes (or chatch rate) to the fishing effort or catch, or age structured models in which equilibrium yields are estimated on the basis of growth and mortality rates.

Production models have been used in New Zealand to make sustained yield estimates for Hauraki Gulf snapper (Elder, 1979) and for rock lobsters, Jasus edwardsii (Saila et al., 1979). For both fisheries there was a long series of data, whose most recent portions fell well to the right of the peak of the production curve, indicating that fishing effort should be reduced.

Age-structured models have been used in New Zealand for tarakihi, Nemadactylus macropteru (Vooren, 1973), red gurnard, Chelidonichthys kumu (Elder, 1976), snapper (Vooren and Coombs, 1977), sand flounder, Rhombosolea plebeia (Colman, 1978) and trevally (James, in prep.). These studies have concentrated on estimating the yield per recruit or equilibrium yield and have been of most value in providing advice about age at first capture.

Methods for studying the dynamics of marine populations such as cohort analysis, or non-equilibrium behaviour of production or age-structured models, have not been widely used in New Zealand. Simulation models have been constructed to illustrate the behaviour to be expected in the face of varying recruitment for two shellfish species: paua, Haliotis iris (Sainsbury, Ms) and dredge oysters (Allen, 1979). Vooren (1973) used an age-structured simulation to show the effects of a developing fishery on tarakihi stocks. It is expected that New Zealand's increasing interest in the southern bluefin tuna (Thunnus maccoyii) fishery, for which there is a long series of age composition data, will involve New Zealand scientists in studies of the population dynamics of this species.

Table 1 provides a summary of the annual catch and the types of stock assessment that are available for the major species taken in the New Zealand EEZ in at least part of their range. In most cases assessments have been made by foreign as well as New Zealand scientists, and in the case of southern bluefin tuna, for which the fishery in the New Zealand area is part of an international fishery, all assessments to date have been done by Australian and Japanese workers.

4. DISCUSSION

Of the major fish and shellfish species shown in Table 1, only three: snapper, southern bluefin tuna and rock lobster can be said to have been assessed sufficiently well for research results to play a major role in management to maximize returns from the fishery. In other cases, where management measures have been applied, the objectives have been based on keeping the situation stable rather than on achieving the most appropriate exploitation rate. Clearly the situation is better for the traditional inshore species mentioned in Table 1 (snapper, tarakihi, rock lobster, trevally) than for the deep-water species. This is to be expected both on the grounds of the amount of research carried out (for example, some snapper studies were carried out in the 1950s (Cassie, 1955; Longhurst, 1958), and were followed by a sustained effort since the mid 1960s) and of the accessibility of the inshore species. However, even for these species no adequate long-term series of catch, effort and size or age composition data are available. This can be partly related to the difficulties of collecting information from an industry which was principally directed toward local supply and was fragmented across ports of landing spread all across the country, the absence of adequate statistical systems and partly to the fact that fisheries research in New Zealand has been directed toward stock assessment for little more than ten years.

The major snapper stock and the rock lobster stocks are under management which is based on current stock assessment. The situation for trevally is of particular interest because research advice to limit catches from one stock was not acted on in time. Subsequently, the stock declined dramatically.

The two tuna species mentioned are special cases because the stocks are exploited internationally. Southern bluefin tuna appears to comprise a single stock which has been the target of intensive research by Australian, Japanese and, recently, New Zealand workers. This research has produced a fairly comprehensive assessment for the species. The skipjack which are present in New Zealand waters during summer are part of the large Pacific populations whose stock structure is not well understood. Tagging results show that fish exploited in New Zealand are also captured in other parts of the South Pacific (Kearney, 1981), and thus the New Zealand fishery for this species may also have to be assessed as part of an international fishery.

The more recently developed fisheries for species such as hake, hoki and southern blue whiting, have been the subject of surveys to estimate biomass. The interpretation of these surveys is made difficult because of ignorance about catchability and incomplete knowledge of distribution of stocks. These problems will be partially remedied by future surveys which should seek to provide solutions to them. The biomass estimates have been used as a basis for catch quotas for some species, but there is little confidence in their accuracy.

Orange roughy (Hoplostethus atlanticus) and oreo dories (Pseudocyttus maculatus and Allocyttus sp.) offer new problems to fisheries scientists. Because of the depths at which these stocks are found established, techniques such as tagging cannot be used, and aging from the interpretation of growth marks in hard parts such as otoliths is proving extremely difficult and may be impossible. Consequently, we have little information about the age, growth and mortality of these species and alternative techniques may require investigation. New Zealand does not yet have a research vessel capable of working the offshore areas exploited by the new fisheries and virtually all the data has come from commercial operations. These are concentrated in areas with high catch rates of the commercially important portions of the stock such as large fish, and are of limited value without additional more systematically collected data. Thus for these fisheries there are no assessments in which the scientists can feel confident and which can be used as a basis for management advice.

Table 1

Estimates of annual catches and types of stock assessment for major species in the New Zealand EEZ[a/]

Species	'000 t	Stock assessment
Squid	60	Biomass estimates, severe problem with catchability and assessment of stock size for annual species
Southern blue whiting	29	Biomass estimates, accurate to an order of magnitude
Hoki	30	Biomass estimates, accurate to an order of magnitude
Orange roughy	27	None
Oreo dories	24	None
Barracouta	18	Biomass estimates, accurate to an order of magnitude
Snapper	12	Equilibrium yield and good biomass estimates for the major stock
Skipjack	9	Biomass estimates. Firm lower bound of biomass in New Zealand area
Southern bluefin tuna	7	Cohort analysis for entire stock
Jack mackerel	6	Biomass estimates accurate to an order of magnitude
Tarakihi	5	Equilibrium yield for one stock, biomass estimates accurate to an order of magnitude
Rock lobster	4	Equilibrium yield
Trevally	4	Equilibrium yield

a/ Catches are provisional estimates for years ending 31 December 1980 for snapper, skipjack tarakihi, rock lobsters and trevally; 31 September 1981 for squid; 31 March 1980 for southern blue whiting; and 31 March 1981 for the other species

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MARINE FISHERY RESOURCES ASSESSMENT IN THAILAND

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1. INTRODUCTION

The results of the marine resources surveys that have been done so far in Thailand, both in the Gulf and along the Indian Ocean coast, indicate that the fishery resources are rich both as regards varieties and quantities.

Since the early 1960s the fisheries industry has rapidly developed and expanded. This has resulted in the fishery resources, both demersal and pelagic, being subjected to intense fishery.

Several scientists of the Department of Fisheries as well as experts attached to the regional bodies have reported the status of marine fishery resources. It was found that there has been overfishing of demersal resources and the abundance, as shown by the catch rate, has drastically declined. The most economically important species of pelagic fish are also considered to be fully exploited.

The marine fishing industry is now confronted with serious problems due to the heavy exploitation of the fishery resources, and it is expected that the decline in landings of marine fish will continue in the future. Appropriate management should be implemented effectively based on the results of a reliable resources assessment study.

2. ASSESSMENT PROGRAMMES

2.1 Demersal Resources

Systematic trawl surveys using research vessels have been carried out by the Marine Fisheries Division, Department of Fisheries, both in the Gulf and along the Indian Ocean coast of Thailand since 1966. The results from these surveys have been utilized to assess the current status of coastal demersal resources. These include a great number of species and the yield assessments have, therefore, been made for the demersal resources that are caught a particular type of fishing gear such as trawlers, considered as whole.

In recent years, shrimps have contributed a substantial quantity of the trawl catch. Recognizing this fact, shrimp resources surveys have also been conducted by two research vessels since 1973 in order to assess the abundance and distribution of the shrimp stocks in the Gulf of Thailand. The shrimp stock assessments have been done separately for two groups, namely, large and small shrimps.

Research activities currently undertaken by the Marine Fisheries Division have been expanded to include studies on some economically important species or group of species including Priacanthus spp., Nemipterus spp., Saurida spp., Trichiurus haumela, squid and cuttlefish.

2.2 Pelagic Resources

The most common and commercially important pelagic species consist of Rastrelliger spp. (R. kanagurta and R. brachysoma), Scomberomorus spp. (S. commerson is the most important species), coastal tuna (Auxis thazard, Euthynnus affinis and Thunnus tonggol), Decapterus spp. (D. maruadsi and D. macrosoma are important), Sardinella spp. (S. gibbosa is the predominant species), Stolephorus spp. (S. heterolobus and S. indicus are important), carangids (Selar crumenophthalmus, Selaroides leptolepis and Atule mate are most common), Megalaspis cordyla, Chirocentrus dorab, Pampus spp. and Formio niger.

The pelagic species for which stock assessment is currently being carried out extensively is the Indo-Pacific mackerel (Rastrelliger brachysoma). Attempts have also been made to give a preliminary estimate of the potential yield of some other pelagic stocks, namely, Indian mackerel (Rastrelliger kanagurta), sardines (Sardinella spp.), scads (Decapterus spp.), anchovies (Stolephorus spp.) and Spanish mackerel (Scomberomorus spp.).

At present, attempts are being made to assess the stocks of other important pelagic species, namely, hard tail scad (Megalaspis cordyla), coastal tuna and carangids.

3. DATA AND METHODS USED

The basic data are the annual statistics of catch and effort by gear and by species group which are obtained from the Annual Fisheries Statistics, the monitoring trawl surveys by research vessels, logbooks of purse seiners and the results of the monthly sampling surveys of the biologist teams.

These data, however, are not in the ideal form required for precise analysis, but nevertheless, in spite of their shortcomings, they provide some useful information enabling a preliminary analysis to be made.

A study of change in stock indices, i.e., total catch by weight, catch per unit of fishing effort (or stock density index), stock size index, effective fishing effort, effectiveness of fishing effort and the change in percentage of species composition in the catch, makes it possible to obtain an evaluation of the state of exploitation of demersal fisheries (e.g., trawl fishery) and pelagic fisheries (e.g., Thai purse seines, luring purse seines, anchovy purse seines, drift gillnet and encircling gillnet).

Based on the analysis of catch and effort data obtained from commercial fisheries, Schaefer's model (Schaefer, 1954) and its derivative (Fox, 1970) are used for comparison in the study of pelagic, demersal and shrimp stock assessment. By observing a linear or non-linear negative relationship between the catch per unit effort and the fishing effort, the yield curve that shows the relation between the total catch and its associated effort was established and then the maximum sustainable yield could be calculated. Regarding the demersal resources study, the data used were those obtained from the inter-calibration of fishing power between research vessels that are considered as standard gear and commercial vessels.

These models are in popular use for resource assessment in Thailand. However, the assessment is based on the assumption that only one stock exists or else that the total of the stocks examined represents a single entity and the interaction between stocks is disregarded. One exception is the stock assessment study of Rastrelliger brachysoma for which stock identification makes a distinction between western and eastern stocks.

Other useful data for the study on stock assessment, of marine resources in Thailand obtained from biological studies of some particular species, i.e., the Indo-Pacific mackerel (Rastrelliger brachysoma), includes growth parameters, mortalities rate, size/age composition and migration. The dynamic pool model using the combination of those biological parameters (Beverton & Holt, 1957) is also employed to establish the yield isopleth diagram for the Indo-Pacific mackerel stock in the Gulf of Thailand.

Recently, acoustic survey techniques for determination of the biomass of small pelagic resources have also been used.

However, the results obtained from the methods mentioned are not fully satisfactory nor entirely reliable. Perhaps, better results will be obtained when several of those methods are combined.

4. REVIEW OF THE RESULTS FROM STOCK ASSESSMENT STUDIES IN THAILAND

Many studies have been made to assess the potential of demersal and pelagic resources in Thai waters both in the Gulf and along the Indian Ocean coast of Thailand during the past decade.

4.1 Resource Assessment in the Gulf of Thailand

After having completed experimental trawling in the Gulf of Thailand, Tiews (1962) estimated the minimum size of the potential yield of demersal resources as between 250 000 t and 375 000 t and indicated that the true value was likely to be higher.

Gulland (1968) estimated the total potential of demersal fish stock along the coast of the Gulf (water 0-50 m depth) as 400 000 t and the central part of the Gulf (waters beyond the 50 m depth) as 250 000-400 000 t. He concluded that the Gulf of Thailand waters had above average productivity.

Isarankura (1969) presented an estimate of the potential of demersal fish stock using he catch and effort data obtained from the research vessel surveys during 1961 to 1969, and oncluded that the exploitation of these fish has reached the level of maximum sustainable ield (MSY) since 1966, with an estimated level of about 450 000 t.

Gulland (1972), in using the total demersal landing by Thai commercial vessels and the atch per unit effort by research vessels in the waters along the coast of the Gulf at 0-50 m epth, gave an estimate of the total potential as 500 000 t, which is equivalent to about 6 t/ m^2.

Shindo (1973) estimated the potential yield of demersal fish stock in the Gulf of Thailand rom the available data on catch and effort up to 1970 as 714 000 t.

However, several Thai scientists made new estimates of the potential yield using the data n total demersal catch by commercial vessels and the data on cpue by research vessels during 961-77. The results obtained from their estimations did not differ much: they ranged from 55 000 t to 687 000 t (Boonyubol et al., 1976, 1977; SCSP, 1978; Thai Country Paper, 1979).

As regards the shrimp stocks in the Gulf of Thailand, Vibhasiri (1980) estimated the otal potential yield to be about 124 000 t, which seems to exceed the current production by bout 20 percent. Furthermore, the examination of the potential yield of shrimp was carried ut separately for two main components, namely, large and small shrimps. The potential yield f large shrimp was estimated at about 25 690 t, and it was concluded that the large shrimp s likely to have been fully exploited since 1973. Therefore, an increase in shrimp produc- ion would derive only from the small shrimp component.

Supongpun (1979) presented the preliminary estimate of the potential of squid stock sing catch and effort data from commercial fisheries during 1971 to 1977 as 70 000 t. She ncluded that squid stock was heavily exploited in 1977, to the extent of 7 percent above he maximum sustained yield.

Taking into account the state of pelagic fish stock in the Gulf of Thailand, Kurogane t al. (1971), using the catch and effort and biological parameters of the Indo-Pacific ackerel (Rastrelliger brachysoma), gave a first estimate of the potential yield as 60 000 t. hey concluded that the exploitation of this resource had reached the optimum level. A slight eduction in the size at first capture or a further increase of fishing effort would result n only a small gain in the total yield.

Menasveta et al. (1973) gave the preliminary estimate of the potential yield of pelagic esources (excluding Spanish mackerel and tunas, but including squid and cuttlefish) as about 80 000 t, of which, the potential of the Indo-Pacific mackerel was estimated to be about 0 000 t.

Hongskul (1974), re-examining the data of Kurogane et al. (1971) in his study of the opulation dynamics of "pla tu", Rastrelliger brachysoma, concluded that the "pla tu" popu- ation did not appear to be overexploited, and that a further increase in production might e possible through increased fishing intensity or a reduction in the size at first capture. owever, he suggested that the fishing intensity should not be increased beyond the 1966 evel in view of the inadequate information available on the spawner-recruit relationship nd also the increased activities of trawlers, whose catches include mackerel in the Gulf.

Chullasorn and Yusukswad (1977) presented the preliminary estimate of the potential ield of the roundscads (Decapterus spp.) as slightly over 100 000 t, and concluded that uring 1973-76 the stock was underexploited.

Recently, the Marine Fisheries Division of the Department of Fisheries organized a eminar on the Marine Fisheries Development Programme in 1978. The potential yield of arious pelagic fish stocks was estimated, based on the relationship between catch and ffort data. The potential yield of mackerels, roundscads, sardines, anchovies and tunas

was estimated as 62 000 t, ≥ 100 000 t, ≥ 150 000 t, 20 000 t and ≥ 10 000 t, respectively. The results of the assessments indicated that most pelagic resources are not in a state of heavy exploitation, except the mackerel stock on the west coast of the Gulf, which has been subjected to intense fishery and may be overfished.

Subsequently, Chullasorn and Shindo (1980) presented a preliminary study on the present status of pelagic fisheries. Five major types of pelagic gear, namely, Thai purse seine, luring purse seine, anchovy purse seine, encircling gillnet and drift gillnet were studied. Calculation of several fish stock indices were made and it was concluded that no definite sign of overfishing was yet apparent but some signs of overfishing by certain gear, i.e., luring purse seine and encircling gillnet, were discussed.

Chullasorn and Shindo (1981) estimated the potential yield of scad stocks to be about 110 000 t and concluded that the fully exploited state had been reached around 1977 but that definite signs of overfishing were not yet clearly observed.

The Exploratory Fishing Division (1981) applied the acoustic survey techniques for the determination of abundance of small pelagic resources, and the first estimation of total biomass of the small pelagic fish in the Gulf of Thailand during the monsoon season in 1979 was estimated to be 130 000 t, which seems to be substantially underestimated.

4.2 Resource Assessment Along Indian Ocean Coast of Thailand

Isarankura (1971), after reviewing the data on catch and effort during the years 1965-68, estimated the standing stock of demersal resources in the coastal waters of 10-60 m depth to be 154 000-224 000 t with the level of maximum sustained yield of about 85 000 t, which appeared to have already been reached by 1968.

Mar et al. (1976) examined the additional data and concluded that the MSY of demersal stock was likely to be substantially greater, probably around 150 000 t.

The FAO/UNDP/SCSP organized the Workshop on Fishery Resources of the Malacca Strait in 1976. The results of the Workshop showed the estimated MSY of the demersal stocks within a 90-m depth contour to be about 200 000 t.

Bhatia and Chullasorn (1980), using the data on total demersal catch by commercial vessels and cpue of research vessels during the years 1966-77, estimated MSY as 205 460 t and suggested that the MSY had probably been reached by 1974. By increasing the fishing effort in 1976-77 to nearly double the calculated optimum effort in 1974, the demersal catch has therefore declined a lower level than the MSY.

Attempts have also been made to assess the potential of shrimp and squid resources along the Indian Ocean coast of Thailand. Bhatia et al. (1979) employed the data on the catch rate by research vessels and total catch by commercial vessels to establish the yield curve. They estimated the potential of shrimp and squid resources to be about 7 800 t and 10 000 t, respectively. Vibhasiri (1980), using the data from commercial fisheries only, gave the estimate of MSY for shrimp resources as about 14 000 t, which seem to have been fully exploited by 1977. However, it should be noted that the increase in both total catch and catch rate in 1978 may be derived from the large shrimps caught in the upper Bay of Bengal.

As regard the pelagic fish stock, Bhatia et al. (1979) estimated the MSY of mackerels (Rastrelliger spp.), which is the most important pelagic species group based on the relation between total catch and its associated fishing effort of the commercial fishery during 1969-77, as 31 926 t.

Bhatia and Chullasorn (1980) re-examined the catch and effort of the commercial fishery during 1971-78. By using Thai purse seine, the most important fishing gear for mackerel fishery, as standard gear, the estimated MSY of the mackerel stock was given to be 20 000 t. They also presented the estimated potential of other pelagic resources, namely, sardines (Sardinella spp.) and anchovies (Stolephorus spp.) as not less than 5 000 t and 7 700 t, respectively, and concluded that the status of those resources may be lightly exploited.

The potential of other pelagic resources, i.e., king mackerel, wolf herring, tunas, scads, hardtail scad, mullets and others, was tentatively estimated at the Malacca Strait Workshop in 1976 as 4 000 t, 2 000 t, 5 000 t, 5 000 t, 5 000 t, 3 000 t and 4 000 t respectively.

Since the maximum sustainable yield for total pelagic resources is considered to be around 60 000 t, while the mean catch during 1971 to 1978 was only 39 000 t per year. just slightly more than half of the potential, the fisheries of pelagic resources along the Indian Ocean coast of Thailand appear to be capable of some expansion in the future.

5. PROBLEMS AND CONSTRAINTS IN MARINE FISHERY RESOURCES ASSESSEMENT

Marine fishery resources assessment that has been done so far in Thailand is facing many problems such as the adequacy and reliability of the data collected, methodology and technique of assessment as well as expertise of biologists who are directly responsible for studies in this field.

The reliability and the adequacy of the data collected are still regarded as a major problem, and are due to the difficulty in collecting data from fishermen and the fishery industry through the sampling surveys and logbook system. As in other developing countries, the fishermen and the industry mostly provide an underestimate and incorrect information, particularly as regards the catch and effort statistics, and fishing grounds.

As far as the existing information on catch and effort by fishing gear and by species or group of species, which are the most significant data for stock assessment, is concerned, catch and effort statistics of the important fishing gear are available while statistics of other minor gear have been far from complete. In addition, the catch composition by species that is available at present does not cover all the economic important species both in demersal and pelagic resources. Therefore, stock assessment of some particular species that are of interest could not be done.

From the review presented here, it is evident that biological and bionomic information is inadequate for most of the commercially important species, both pelagic and demersal, except for the Indo-Pacific mackerel stock in the Gulf of Thailand that has been intensively investigated. In order to arrive at a comparable assessment of the status of the stocks employing other models, i.e., the analytical model, biological studies must be carried out or strengthened for those resources that currently form an important component of the commercial catch.

Regarding the methodology and technique employed in stock assessment studies, it is recognized that conventional methods cannot be directly applied in tropical waters such as Thai waters. Therefore, the methodology applicable for assessing the resource potential is a major consideration. The problems on multispecies and multistock as well as multifishery characteristics are considered as the main constraints. Modifications of the conventional methods and/or the development of new approaches for stock assessment are needed.

Although much information concerning fisheries and the fish stocks is available, not all this information is widely used for further population analysis. Information on changes in size composition or species composition from year to year, and the relation between species at the same or different trophic levels need to be taken into account. A further problem is the limited expertise of the biologists who are directly responsible for the stock assessment study and this is considered another constraint. Therefore, training in various levels of fishery biology, particularly in the field of tropical stock assessement, is an essential need.

APPROACHES TO RESOURCE ASSESSMENT FOR LOBSTER, BOTTOM FISH, MONK SEAL, AND GREEN TURTLE STOCKS IN THE NORTHWESTERN HAWAIIAN ISLANDS

by

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1. INTRODUCTION

The Honolulu Laboratory, Southwest Fisheries Center, National Marine Fisheries Service (NMFS), is assessing the stocks of spiny lobster, Panulirus marginatus, a snapper (Lutjanidae) and grouper (Serranidae) complex of bottom fishes, the Hawaiian monk seal, Monachus schauinslandi, and the green turtle, Chelonia mydas, in the Northwestern Hawaiian Islands (NWHI).

The NWHI is an area of reefs, banks and islands located northwest of Honolulu stretching from Nihoa Island 1 250 n mi northwest to Kure Atoll. The spiny lobster and bottom fish resources support a modest fishery in the NWHI. The monk seal is an "endangered" species breeding only in the NWHI and the green turtle is considered a "threatened" species under the US Endangered Species Act.

2. SPINY LOBSTER

The spiny lobster fishery began in 1975 when the NOAA ship TOWNSEND CROMWELL, a research ship assigned to the Honolulu Laboratory, documented good catch rates of spiny lobster, at the lower end of the chain. In 1975 the commercial catch was 2 000 kg. Each subsequent year the catch has increased and the current catch for 1981 is estimated at 300 000 kg (Skillman and Ito, 1981). The rapid development of this fishery has raised concern that overfishing may occur and work to develop a fishery management plan (FMP) was initiated by the Western Pacific Regional Fishery Management Council. The Honolulu Laboratory has contributed to this FMP by undertaking work to: 1) Determine the distribution of the resource throughout the NWHI chain, and 2) estimate the sustainable yield of the resource. The data available for these analyses consist of sampling data collected on research cruises of the TONWSEND CROMWELL, and some commercial catch and effort data.

The data collected by the TOWNSEND CROMWELL represent a systematic sampling survey with catch and effort data collected from 0.1° squares around the banks and islands of the NWHI. This catch-per-unit-effort (cpue) data were used to prepare charts of the relative abundance of the spiny lobster stock throughout the NWHI (Uchida et al., 1980).

The estimation of sustainable yield for the region was based on the commercial catch and effort data base. There currently is no regulation that requires commercial vessels to report their catch and effort and, hence, only an intermittent catch and effort data series submitted on a voluntary basis was available. While the catch and effort time series were too short and sporadic for surplus production analyses, a series of catch and effort data which represented intensive trapping applied to a previously unexploited population was available for analysis. Based on this intensive catch and effort data, an estimate of pre-exploitation population size (N_0)and catchability (q) could be obtained by computing a regression of cpue on cumulative catch (Leslie method, Ricker 1975, p. 150).

Another approach to estimate pre-exploitation biomass was applied to data collected from Necker Island at the lower end of the chain where much of the earlier commercial effort was directed. This approach was based on a method proposed by Allen (1966) in which population size and catchability are estimated in a manner which minimizes the sum of squares between the actual catch and the predicted catch, given effort. In its most general form, this model assumes that the rate of natural mortality is constant while recruitement may vary over time. This most general form requires that the user supplies estimates of the natural mortality and recruitement rates. We did not have any estimate of recruitement rate and hence modified Allen's model. We assumed that the ratio of the rate of natural mortality to the recruitement rate was constant over the two-year period for which data were available. This ratio together with population size and catchability are then estimated by least squares. Application of this method to 24 months of commercial catch and effort data from Necker Island produced estimates of catchability and population size which were in agreement with the estimates obtained from the same site by an intensive fishing analysis (Polovina and Tagami, 1980).

Once pre-exploitation population size, and hence biomass, were obtained for several areas where research sampling cpue data were available, a linear regression of biomass per unit area on research sampling cpue was used to obtain an estimate of total biomass for the entire NWHI. Based on this total estimate of pre-exploitation biomass (B_o), rough approximation of lobster maximum sustainable yield (MSY) for the NWHI were obtained based on Gulland's (1971) relationship:

$$MSY = M\ B_o/2$$

where M = annual instantaneous natural mortality,

and a method proposed by Pauly (1981):

$$MSY = 2.3\ \bar{w}^{-0.26}\ B_o$$

where $\bar{w}$ is defined as the average of the weight at first maturity and the maximum weight of the lobster in the population (in grams).

To estimate natural mortality (M) for Gulland's relationship, the following relationship (Beverton and Holt 1956) was used on data obtained at sites with little or no fishing:

$$F+M = K(L - \bar{L})/(\bar{L} - L_{min})$$

where $\bar{L}$ is the mean carapace length from the trappable population, L_{min} is the minimum carapace length from the trappable population, and K and L are the parameters from the von Bertalanffy growth equation which were estimated from modal analysis of length-frequency data.

While these methods produced estimates which can only represent rough approximations, it appears that the results nonetheless represent reasonable first approximations. The approach described produced estimates of annual MSY ranging from 100 000 kg to 200 000 kg (WPRFMC, 1981). The yield for 1981 was 300 000 kg; however, the substantial decline in catch rate and lobster size suggests that this yield is not sustainable. Once the FMP is in force and commercial catch and effort data can be collected, it is anticipated that these estimates will be revised.

Two difficulties encountered in this analysis were the availability of only short and sporadic commercial catch and effort data and the difficulty of obtaining precise estimates of growth parameters. Both tagging data and analysis of modes and modal progressions of length-frequency data were used to estimate growth parameters. The tagging approach suffered from insufficient recoveries and relatively slow apparent growth for the animals recovered possibly due to an effect of tagging on growth. The analysis of length-frequency data showed large variances in growth due to the difficulty in identifying modes which was apparently caused by the large variance in size among lobsters of the same cohort.

3. BOTTOM FISHES

The bottom fish fishery exploits a complex of species, especially snappers (Pristipomoides spp., Etelis spp., and Aprion virescens), but including also jacks (Carangidae: Caranx spp., Carangoides spp., and Seriola dumerili) and a grouper (Ephinephelus quernus). The fishery is conducted in deep (60-340 m) offshore waters using baited hook-and-line gear, and powered mechanical line-haulers.

Bottom fishes have been exploited around both the main Hawaiian Islands and the NWHI since at least 1945. However, until recently only one vessel regularly fished in the NWHI. Recently more commercial vessels have begun exploiting bottom fish stocks in the NWHI, but the data base of commercial catch and effort for the NWHI is not sufficient to perform a stock-production analysis. A larger data base for comercial catch and effort data around the main Hawaiian Islands is available and a stock-production analysis of the bottom fish resource around the main islands of the State was completed using a 20-year series of catch data collected by the Hawaii Division of Aquatic Resources (Ralston and Polovina, in press). Although fishing effort statistics were not specifically maintained, a computer program sorted through the data base and tallied the number of fisherman-days expended each year in the fishery. The stock was treated as a multispecies fishery and analysed by application of the Total Biomass Schaefer Model (TBSM) (Pope, 1979). Cluster analysis of the data showed that bottom fish species could conveniently be divided into three somewhat distinct groups which appeared to be segregated on the basis of depth and could be analysed by the use of TBSM. Using aggregation theory it was demonstrated that the cluster groups provided a more accurate and biologically meaningful way of expressing production in a multispecies framework. The analysis also showed that the fishery is currently close to MSY.

The chief liability of this study was that the measure of fishing effort which was employed had to be determined after the fact. Interpretation of the statistic used became most difficult as a result. Furthermore, the recreational catch of bottom fish in Hawaii is unreported and thus unaccounted for. Consequently, estimates of surplus production from this analysis can only be considered as a lower bound for yield potential.

A yield-per-recruit analysis of Pristipomoides filamentosus has also been completed. This is the most important species in the fishery and it was studied in some depth to complement the results of the stock-production study. In an investigation of the growth dynamics of this species, the density of daily increments in sagittal otoliths was integrated to estimate age (Ralston and Miyamoto in press). The daily periodicity of the increments was validated by in vivo tetracycline labelling of otoliths and examination of shifts in field-sampled size-frequency distribution. An age-length key was generated from regression statistics derived from the estimated age-length data. This key was then applied to length-frequenc samples to estimate mortality rate using the catch-curve method. Experimental fishing trials were conducted to assess the likelihood of severe size bias in these hook-and-line samples. T yield-per-recruit calculations for P. filamentosus showed that eumetric conditions currently prevail for this species at a relatively high level of yield (Ralston, 1981). This result is considered compatible with the finding that the fishery is now operating close to its MSY.

A major difficulty in these studies was the labor-intensive nature of working with daily increments in otoliths. In this regard, the growth of P. filamentosus remains the topic of ongoing study, as is the growth of other bottom fish species. Furthermore, more extensive length-frequency samples of these fishes would have been desirable.

The results of these stock assessments have shown that the bottom fish resources of the main Hawaiian Island are currently being intensively exploited and yet further expansion of the fishery into the NWHI appears feasible on biological grounds. Ancillary studies concerning the diets and fecundities of selected bottom fish species are also currently being pursued (Uchida, Ito and Uchiyama, 1979), and these should assist in the management of bottom fish stocks.

4. HAWAIIAN MONK SEAL AND GREEN TURTLE

Both the Hawaiian monk seal and the green turtle are protected under provisions of the US Endangered Species Act. Assessing the status of their populations for stock protection and rehabilitation is therefore a major goal of the Honolulu Laboratory.

The programme for assessment of green turtles is in its second year. The long-range objectives are to gather information on reproductive ecology, migratory patterns, growth rates, mortality rates, and other life history characteristics which will lead to an understanding of turtle population dynamics. Mark-and-recapture techniques will be used extensively. Metal flipper tags have been applied by non-NMFS biologists to over 1 100 turtles since 1973, but mostly to adult animals in the NWHI. In 1981 NMFS scientists experimented with tagging of green turtle hatchlings using auto-transplanted tissue plugs. Results were very promising, so in 1982 the Honolulu Laboratory will mark several hundred hatchlings with reversed scute plugs as they leave their nests at French Frigate Shoals.

Honolulu Laboratory research on the Hawaiian monk seal is also in its second year. Past work has been carried on by sientists from the Department of the Interior, the Department of Commerce, and by researchers on contract to the Honolulu Laboratory and to the Marine Mammal Commission.

Part of the 1981 programme involved the development and implementation of a recovery plan for the monk seal population, and this included an outline of research needs for stock assessment and an understanding of seal population dynamics. A variety of assessment techniques might be employed, including aerial and ground counts to develop abundance indices and mark-and-recapture methods using natural marks, bleach marks, or tags.

During 1982 a pilot tagging project at Lisianski Island will be undertaken to test the suitability of plastic cattle tags applied to the hind flippers of about 15 weaned monk seal pups. The tagged pups will also be bleach marked, as will an equal number of untagged pups. Data will be collected on temporal and spatial aspects of haul-out behavior, inter- and intra-specific interactions, and on other aspects of their early life history. If the effects of the tagging procedure and the presence of the tags are judged to be insignificant, a pup-tagging programme throughout the breeding range of the Hawaiian monk seal will be proposed for 1983.

Tags may also be applied to adult seals in future research. The tagging studies will produce critical information on age- and sex-specific mortality rates, age at first reproduction, reproduction rates, inter-island movement, and population size.

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ANNEX 3

On the Development and Dissemination of New Methodologies for Tropical Stock Assessments

by

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Abstract

The use of length-structured methods for the assessment of fish stocks is reviewed in relation to the present status of tropical fisheries science. It is concluded that these methods, which emerged largely as a result of the development of sophisticated, yet relatively cheap, programmable calculators and microcomputers, will enable significant advances to be made in assessement of tropical stocks.

It is proposed to disseminate the length-structured methods and other methodologies through a management-oriented fisheries-research network which will enhance communication between fisheries scientists who are working on problems of assessment, management and conservation of tropical stocks. The principal mode of communication will be via a newsletter.

INTRODUCTION

Fisheries science emerged towards the end of the last century in response to the first igns of what was later to be called "overfishing". As a result of the development of the cience, fisheries biologists in temperate regions are now routinely able to respond to equests for scientific advice on the state of various fish stocks and make management ecommendations concerning allowable catches, restrictions on effort and closed seasons nd areas. The kind of research which leads to the ability to formulate management strategies s called, by ourselves, "management-oriented fisheries research".

In tropical waters there are exceedingly few examples of fisheries which are managed on he basis of options formulated as a result of management-oriented research. For the most art, fisheries are either unmanaged or are "managed" on the basis of ill-founded perceptions f the status and potential productivity of the stocks and undocumented recollections of the istory of the fishery. The reasons for this situation are not difficult to discern and elate to the biology of the fishes, the nature of the fisheries and to the institutions esponsible for fisheries and management in the tropics.

The biological constraints include the large number of species in the total catch, with ew single species important enough to warrant a major research effort, difficulties in geing fish because of the usual absence of readily discernible periodic growth marks, difficulties in obtaining statistically meaningful samples of individual species and our inadequate understanding of the complex interactions between the species constituting the exploited ommunities.

These constraints are matched by a set of characteristics pertaining to tropical isheries, many of which are exploited by a vast number of competing fishermen operating a ide array of gear types and landing their catches at points dispersed over innumerable small eaches adjacent to a variety of fishing grounds. The fishermen are most often illiterate, overty-stricken, unorganized and suspicious of activities of research workers.

The institutional constraints mostly have a historical basis and include a shortage of adequately educated or trained fisheries scientists, the high cost of imported scientists, poor perception of the practical possibilities of fisheries management by administrators and politicians and thus inadequate financial support for research activities.

However, the greatest constraint of all lies in the scientific personnel attached to fisheries institutions, who are often not well versed in matters relating to fish stock assessment. Apart from the complexities of tropical fisheries which have been previously mentioned, the mathematical aspects of stock assessment are intimidating for most biologists and are often actively avoided. Clearly, dealing with all of the constraints at the same time is almost impossible for any organization. However, partial advances are feasible and this paper discusses a possible approach based on the wide dissemination, through a special "network", of the new methodology that has emerged, since the mid-seventies, for the investigation of tropical stocks. In the following, we review the major features of this new methodology, then present a modus operandi for its dissemination.

2. A NEW METHODOLOGY FOR TROPICAL STOCK ASSESSMENT

Dealing first with the biological properties of tropical stocks, we wish to stress that tropical stocks often fail to exhibit the properties attributed to them or that these properties, far from representing liabilities, can be turned into assets. Thus, for example, the feature that many tropical stocks in South and Southeast Asia consist of very short-lived fishes, allows one to follow the growth and decay of a cohort of fish within a year. If there are also well-defined periods of recruitement (which is often the case, contrary to a widely held assumption), one can often determine growth from length-frequency data without encountering many of the problems occurring when this approach is applied to long-lived temperate fishes and estimate total mortality rate from length-frequency data on an annual basis, i.e., for distinct cohorts.

Additionally, the short life span of many tropical fishes enables one to neglect time-lag effects, for example, when fitting Schaefer-type production models to catch and effort data, when estimating mortalities from catch composition data or when estimating absolute annual recruitment from a division of yield-per-recruit estimates into annual catch.

The large number of species encountered in most tropical fisheries, which most authors have generally considered to represent nothing but a major nuisance, may also be viewed as a beautiful set of replicates from which not only one, but several sets of parameter estimates can be obtained, e.g., to assess the impact of fishing on a multispecies stock (Munro, 1974; Weber and Jothy, 1977; Pauly 1979, 1980a).

The assessment of commercially exploited fish stocks depends heavily upon a sound knowledge of growth, and "natural" and "fishing" mortality rates. In temperate countries routine ageing of large number of samples from the few important species is feasible, and information on growth and mortality is derived from this age data by "age-structured" models. It is also possible to use "length-structured" models to get this information directly from length data. Length-structured methods have become very important to fisheries research in the tropics, and their evolution is briefly reviewed in the following paragraphs and summarized in Table 1. Three phases may be distinguished in the development and evolution of these methods:

(i) a "pioneer" phase around the turn of the century, dominated by the work of C.G. Petersen, T.W. Fulton and T. Edser;

(ii) a "classic" phase in the late 1950s to mid-1960s in which the concepts proposed by R.J.H. Beverton and S.J. Holt were translated into their length-structured equivalents, and

(iii) a "baroque" phase, starting in the mid 1970s, resulting in the development of methods of increasing sophistication and applicability for the estimation of growth and mortalities from length-frequency samples. This phase developed largely as a result of the wider availability of programmable calculators and microcomputers.

Petersen (1982) developed both techniques commonly used for the extraction of growth nformation from length-frequency samples; these methods may be called the "Petersen method sensu stricto)" and the "modal class progression analysis". Both techniques, when used ith judgment, give reasonable results when applied to representative, well-structured amples; they have become virtually the sole method used more or less routinely in the ropics to obtain growth data. Several refinements to these methods have been proposed, otably their use in conjunction with graphical (Cassie, 1954; Harding, 1949) or computer- ased (Hasselblad, 1966; Tomlinson, 1971; Young and Skillman, 1971) techniques for the eparation of multi-peaked samples into normally distributed subsets. Still, all of these ethods and their variants (e.g., the "integrated method" of Pauly, 1980b, remain essentially ubjective, and produce results which are not fully reproducible.

Beverton and Holt's major contribution to the available pool of length-structured ethods were the establishment of the relationship between mean length in catch samples and otal mortality[1/] and the reformulation of their yield-per-recruit model in a form in which he original 7 parameters are collapsed into three parameters, one of which is the ratio of he mean length at first capture to the asymptotic length of fishes (Beverton and Holt, 1964).

The third, "baroque", phase of development of length-structured models has led to the evelopment of a variety of methods for assessing stocks, based almost exclusively upon the ength-frequency distribution of catches. Of these methods (listed in Table 1), (6) derives stimates of growth and mortality from length distributions at two time periods, (7) estima- es population size and fishing mortality, by size group, from catch-at-size data, obtained y combining length-frequency data with catch statistics while (8) is a modification of ength cohort analysis such that the results are independent of the width of the length class sed (which affects the accuracy of the results in (7)). Length-converted catch curves (9) nd "pseudo catch curves" (10) are methods to obtain estimates of total mortality from epresentatives length-frequency samples of a population and a set of growth parameters, the rmer method being the length-structured equivalent of a standard "catch curve", while the tter method (10) uses the interrelationships between depth, abundance and mean length to nstruct the functional equivalent of a catch curve.

The set of ELEFAN programs are particularly useful in that they allow for the extrac- ion of virtually all the information embedded in a given set of length-frequency data, .e., growth parameters (including cases where growth oscillates seasonally), total mortality using several methods), preliminary estimates of natural mortality (and hence, also of ishing mortality), patterns of gear selection and patterns of recruitment into the fishery. lso, when used in conjunction with catch statistics, ELEFAN III can be used to run different ypes of Virtual Population Analyses (VPA) and thus to estimate recruitment as well as ishing mortality, by length classes and in time (Pope, Pauly and David, in prep.). All ELEFAN rograms are in BASIC and run iteratively, with automatic prompting of inputs; also, they o not require any equipment outside of the microcomputer itself.

Of the methods in Table 1, eight (1, 2, 4, 5, 7, 9, 10 and 14) can be implemented ither with pencil and paper, or with calculators. Of the remaining methods, (3) produces rroneous results, (6) and (8) can be run with programmable calculators[2/], leaving only the hree ELEFAN programs (11 to 13) as methods which require (micro) computers for their mplementation.

It should be emphasized here that these methods are based on rigorously derived mathema- ical equivalents of age-structured models. Thus, for the methods (4) to (12) in Table 1, he major assumption that is added in the transformation from the corresponding age-structured

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1/ The equation proposed by Beverton and Holt (1956) has the form $Z = K (L_\infty - \bar{L})/(\bar{L} - L')$, where Z is the (exponential) rate of total mortality, L_∞ and K are parameters of the von Bertalanffy growth equation and $\bar{L}$ is the mean length of catch samples, calculated from the smallest size group that is fully selected (L')

2/ Calculator programs (for HP 67/97) incorporating the methods 4-9 and 14 are available from the authors.

model is that the von Bertalanffy growth equation (von Bertalanffy, 1938) adequately describes the growth of the fish in question. This, however, has shown to be the case by a large number of authors (reviews in Pauly, 1978; 1981), despite assertions to the contrary (Knight, 1968; Roff, 1980).

A final point on the usefulness of length-structured models is that very large amounts of length-frequency data are on file at fisheries research stations and laboratories, and in the files of individual scientists, and that these data are virtually unprocessed in the context of the length-structured methodology. Thus, there is the possibility of generating a posteriori extremely useful time series of such important parameters as total mortality, provided it can be established that the data are adequate representations of the length distribution of the catches. In the Philippines, for example, we have been able to locate, document and analyse, using the ELEFAN method, 0.9 million individual measurements of fish (Ingles and Pauly, 1982; in prep.); we also know that similar data sets exist in other countries.

We shall discuss in some detail, in the second part of this paper, some of the constraints which prevent fisheries scientists in developing countries from doing what we have termed "management-oriented fisheries research". Thus, it may suffice to mention here that the methods do exist which can be used for such research, and that all of the methods in Table 1 are available in forms which should allow even moderately well-trained technicians to apply them. Moreover, the costs for hardware needed to support the methods listed in Table 1 are minimal when related to overall expenditures on fishery research. For example, the cost of a fully programmable calculator is perhaps equivalent to 1/2 day in fuel costs for a research vessel or equivalent to the cost of a small navigational error. Similarly, the cost of a microcomputer such as is needed to implement the ELEFAN programmes, or other sophisticated programmes for the detailed analysis of (expensive) data, is perhaps equivalent to 2 days in fuel costs for a research vessel or equivalent to the losses resulting from the use of a sub-optimal cruise track.

3. TRAINING AND ASSISTANCE IN MANAGEMENT-ORIENTED FISHERIES RESEARCH

Despite great efforts by national and international agencies, there has been a remarkable lack of progress in making scientifically sound fish stock assessments in tropical countries. The reasons for the lack of progress in fisheries science are fairly clear. There is a grave shortage of highly skilled manpower in most tropical countries, with internal and external competition for the services of the most skilled and best educated people. Administrative careers emerge as the most attractive avenues for personal development and financial gain. In those countries where there are sufficient biologists to staff fisheries management organizations, those appointed are very frequently faced with heavy administrative responsibilities, have not yet proceeded to undertake graduate work leading to higher degrees and, most often, have received the minimum amount of mathematical training which is consonant with a degree in science.

In many cases, the obvious solution would be to send the individual to a university where suitable graduate training is available but, in many instances, this is impossible for financial, family, or academic reasons. Short-term training courses are a possible means for infusing required items of knowledge but the recipients of such knowledge are not always those most in need of the training and the diverse levels of education and experience of the participants usually ensures that a significant portion are either baffled or bored. A third mechanism which is often pursued is that of "counterpart" training, whereby counterparts are assigned to experienced scientists, most often contracted from abroad by external agencies. However, if this is attended to seriously, it is extremely expensive in terms of man-hours. There is usually an excellent chance of the recipient of any training being deployed elsewhere or moving into a radically different field on completion of the training program. These and other problems have most recently been addressed by ACMRR (1981) and various suggestions put forward for improvements, including improved distribution of FAO manuals.

ICLARM has recently resolved to pursue an alternative strategy for attacking these problems. This will involve the creation of an international network of fisheries scientists who are working on problems of assessment, management and conservation of tropical stocks. To this end, ICLARM will identify scientists who are working in relative isolation in tropical countries and attempt to bring them into contact with fellow scientists with common or similar problems in management-oriented fisheries research. Membership of the network will be on a personal basis and not institutionalized. The principal vehicle for communication will be a newsletter.

ICLARM will provide the following services to the network:

(i) act as a clearing house for information related to assessment and management of tropical fisheries, with particular attention to small-scale, multispecies, multigear fisheries;

(ii) provide, at no cost, relevant literature, including "grey" reports, previously unpublished data sets, reprints of papers which are now out of print, and, where possible, act as a distributor for manuals prepared by other organizations;

(iii) provide, in selected cases, assistance in data analysis, including periods spent in Manila by members of the network or visits by ICLARM staff to the institutions concerned to formulate plans and devise appropriate methodologies;

(iv) ICLARM assistance will also include the development of data-acquisition strategies where no data base exists. This is particularly important where inexperienced scientists have difficulties in identifying which data should be collected, when, how and in what quantities. Great expenditures of time and effort quite often prove abortive because the resulting data sets are incomplete.

These services will be available on a long-term and continuing basis, at no cost to the recipients.

The newsletter will contain exchanges of informal notes, news and views on tropical fish stock assessment and management. The emphasis will be on how to make parameter estimates for stock assessments, application and applicability of various stock assessment models and on management decisions based on such assessments. It will contain program descriptions, worked examples applied to tropical stocks and news on developments in appropriate hardware. Additionally it will describe investigations currently in progress and the problems and pitfalls encountered and their solutions. In other words it will attempt to bridge the gap between perception of a fisheries management problem and the production of a set of recommendations to solve that problem.

Initially the newsletter will be distributed only to members of the network. However, if it is successful, bound volumes will be distributed to libraries of fisheries research institutions.

The final phase of development of the network will be the development of Management-oriented Fisheries Research Groups in individual countries. Such groups will only be set up at the request of individual institutions and will consist of a group of scientists from the country concerned working under the guidance of an ICLARM staff member on the analysis of data sets. The ICLARM staff member will be assigned to such a group for a period of up to two years. Basic equipment such as a microcomputer and programmable calculators will be supplied when necessary. Details of such programs will vary by country and be tailored to the needs of the recipient country.

It is also expected that the network will lead to the identification of topics for training workshops. For example, the need for a workshop to further develop and propagate length-structured stock-assessment methods is already evident. The almost uniform incomprehension of mesh-selection phenomena and methods of treating data biased by gear selectivity suggests a second workshop topic. A third workshop could aim at bringing together social scientists and fisheries biologists for further attempts to formulate cohesive management strategies for various fisheries.

The basic argument put forward in support of the program outlined above is that throughout the topics, both in inland and marine fisheries, recently graduated scientists are faced with problems of data and literature acquisition. The relevant literature is sparse, inaccessible and almost invariably not available in remote field stations or even in major national fisheries libraries. In particular, the individuals concerned do not know who is working on what in the tropics, as the lines of communication often run north-south and not equatorially. The proposed network would remedy this to a large degree.

The initial development of the network will be funded by ICLARM, but continuation of the network will require additional funding support from other sources.

To launch the network, ICLARM is presently distributing invitations to a selected list of scientists who are known to be actively engaged in tropical fisheries assessment work. Membership will be increased by inviting Directors of Fisheries Departments to nominate scientists from their organizations to become members. Further increases in membership will be on the basis of nominations by existing members of the network. It is emphasized that membership will be on a personal basis and not institutionalized.

4. CONCLUSIONS

Recent developments in programmable calculators and microcomputers, and the development of length-structured methods for analysis of exploited populations, have put the most sophisticated fish stock assessment techniques within the grasp of almost all fisheries scientists. What is lacking is the confidence and know-how to attempt assessments utilizing these tools. To most tropical fisheries biologists, computers and programmable calculators are intimidating instruments and the exclusive prerogative of scientists of the wealthier nations. This need not be the case and it is ICLARM's intention to further stock-assessment work by attempting to strip some of the aura of mystery from the work of the population dynamicist and demonstrate that useful stock assessments can be based on minimal amounts of data and equipment, even in multispecies, multigear fisheries.

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Table 1

Selected length-structured methods for use in tropical stock assessment[a/]

Phase	No.	Name of method	Originator(s)	Well-documented application(s) to tropical stocks	Remarks
I	1	"Petersen method"	Petersen (1892)	Goeden (1978)	A combination of these two methods into an "integrated method" is given in Pauly (1980b).
	2	Modal class progression analysis	Petersen (1892)	George and Banerji (1964), Thompson and Munro (1978)	
	3	"Catch curve"	Edser (1908)	not applicable, method too crude	–
II	4	Z from mean length	Beverton and Holt (1956)	LeGuen (1971), Munro (1974)	Variants of this method have been presented by Ssentengo and Larkin (1973), Marten (1978) and Ebert (1981).
	5	length-based (relative) yield-per-recruit analysis	Beverton and Holt (1964)	Munro (1977), Sinoda et al. (1979)	No computation necessary when using this method; results are tabled for a wide range of parameter values.
III	6	Z and K from mean lengths	Ebert (1973)	Pauly (in prep.)	–
	7	Length cohort analysis	Jones (1974, 1979, 1981)	Jones and Van Zalinge (1981)	–
	8	Length VPA	Pauly (in prep.)	example in original description	–
	9	Length-converted catch curve	Pauly (1980a), J.A. Gulland (pers. comm. to Pauly)	example in original description	–
	10	"Pseudo catch curve"	Pauly (1980c)	example in original description	Method requires further refinements.
	11	ELEFAN[b] I	Pauly and David (1981)	examples in original description, in Pauly and Ingles (1980) and Pauly et al. (in press)	Most sophisticated approach to date for detailed analysis of length frequency data; incorporate methods 1, 2, 4, 8 and 9.
	12	ELEFAN II	Pauly et al. (1981 and in press)	same as for ELEFAN I	
	13	ELEFAN III	Pope et al. (in prep.)	example in original description	–
	14	Csirke and Caddy's yield model	Csirke and Caddy (in prep)	not yet available	Included here because catch is plotted on Z or Z/K, both of which can be obtained from length-frequency samples

a/ This table includes methods where length replaces age as an explicit parameter, not methods that are inherently length-structured, such as selection curves. Also, methods for the decomposition of length-frequency samples into normally or otherwise distributed subsets are not included (but see text)

b/ Electronic LEngth Frequency ANalysis; a bit contrived, but one remembers it

ANNEX 4

Microcomputers and Fisheries

by

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1. INTRODUCTION

Research and management relating to living resources require extensive data bases. Because of the multiplicity of species, fishing gear and participating nations, fisheries research and management activities may require much more data than any other resource management area. This situation led fisheries scientists and managers to embrace good record-keeping practices and to apply statistical survey procedures. The resulting large depositories of data contributed materially to the development of quantitative techniques for fishery stock assessment in the early 1900s. The ever-increasing size of the data sets created problems in processing and managing them in a timely and cost-efficient manner. With the development of the computer during World War II and its commercial availability shortly thereafter, a new tool became available for managing and processing these large fisheries data sets.

Fisheries workers adopted this new tool, learned high-level programming languages, such as FORTRAN, to process their data, and proceeded in an effort to gain access to ever bigger, more powerful mainframe computers.

In the middle to late 1970s, developments occurred in the computer field that are only now being recognized and adopted to any great extent in fisheries. These developments include: (1) maintenance of data sets in mass storage devices (disks) attached directly to computers rather than on magnetic tapes to facilitate speedy access for updating or analysis; (2) interactive rather than batch processing; (3) availability of smaller computers called minicomputers; and (4) time-sharing of processing resources on a mainframe computer.

Two recently occurring computer developments are not, except for a few instances, being used in fisheries. One involves a concept called distributed processing, where two or more small computers perform site specific processing but are linked together in a network for sharing of data bases and, sometimes, the processing power of a central, large computer. The second event, which is the subject of this paper, involves the development of the general purpose microcomputer.

In this report, I will describe the general purpose microcomputer, discuss its capabilities, compare its performance specifications to some minicomputers, and finally present some fisheries applications of microcomputers.

In discussing computers, it will be necessary to use words and terminology unfamiliar to most fisheries workers. To make matters worse, the computer field is rich in jargon that is evolving as rapidly as the field itself. I will attempt to avoid as many of the specialized terms as possible but the use of some will be necessary. To facilitate our communication, I have included a short glossary (Appendix 1), which I extracted mostly from McGlynn (1979) and Popular Computing (1981).

2. THE MICROCOMPUTER

2.1 Some Definitions

What is a microcomputer? And, what makes it different from the computers we fisheries scientists have been using all these years? The glossary presents the text book definition, but further explanation seems in order.

A computer system, besides essentially being an assemblage of machines whose purpose is to process information, is made up of several devices - some for inputting information, some for storing if, some for outputting it, and one for processing it. The latter is generally called the central processing unit (CPU). It is the heart of the computer and is purely electronic, not electro-mechanical. The CPU is in turn made up of an arithmetic logic unit, some registers for temporary storage of data, instructions and address (much like the registers on a calculator), an instruction decoder and timing unit (determines what part of the CPU is instructed to do something and when), sometimes a clock, a memory and input-output controller (for communicating with random access memory and the input-output interface), and communication wires (called buses; for transmitting data, addresses and control instructions).

Large mainframe computers or maxicomputers, for example the IBM[1/], Univac and Burroughs machines which have been used for so many years, are products of the electronics industry. In these machines, the CPU is made up of separate electronic units linked together inside a cabinet to accomplish each of the functions of the CPU given above. These units of boxes have gotten smaller over the years, but they are still separate electronic units. In minicomputers, a great advancement was made in miniaturization so that the arithmetic logic unit, the registers, and the instruction decoder and timing unit could be placed together on an electronic board. These electronic boards not only take less space than the electronic units of the maxicomputers, but they are cheaper to manufacture and are more dependable.

Microcomputers are products of the semiconductor industry and are fundamentally different from both mini- and maxicomputers. In this case, all of the processing functions of the CPU are placed together on a single silicon chip smaller than your fingernail. Hence, the phrase "computer on a chip". Technically, the silicon chip is a microprocessor. This chip is placed on an electronic board along with part or all of the random access memory, the clock, the input-output interfacing unit, and extensions of the communication buses. Hence, the entire CPU can now reside on a single electronic board although frequently part of the random access memory is placed on a separate board. This arrangement is cheaper to manufacture and more dependable than that used in the minicomputer.

Thus, the basic difference among maxi-, mini- and microcomputers is the electronic architecture. What about using processing capacity as a means of defining these types of computers? In general the maxicomputers are capable of doing more processing faster than mini- or microcomputers. However, as minicomputers improved, they became capable of performing the same work in less time and at less cost than smaller, less capable maxicomputers. Hence, the more efficient minicomputers have displaced the less efficient maxicomputers from the market place. Similarly, advances in microcomputers have resulted in the displacement of the smaller, less capable minicomputers. Today, a microcomputer costing US$ 2 000-3 000 is more powerful, faster and more compact than the first computer costing millions of US dollars. The processing power of each of the computer types is advancing rapidly and will continue to do so for the foreseeable future; hence, processing power is not a good means for characterizing types of computers.

1/ Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA

2.2 Some Early Uses

The microprocessor was originally created to handle routine, set tasks commonly used in controlling manufacturing processes. It was only later that the microcomputer, encompassing the microprocessor, was used for manufacturing, business, and scientific applications. Some of the first applications of microprocessors in science were to interface between laboratory or field instruments and some recording device or a computer. In fisheries and oceanography, microprocessors are used with instruments measuring temperature, conductivity, pressure, current, and weight. In such instruments, they can be used to control the rate at which the sensory instruments operate, to convert the devices' analog signals to digital signals for subsequent analysis on computers, and to filter, smooth or average data generated by sensory instruments. They calculate salinity from temperature, pressure, and conductivity readings and the position of ships from satellite signals (see Mini-Micro Systems 1979 for a description of a forerunner to the off-the-shelf satellite navigation instruments that are available today). They can be used to estimate the potential amount of naturally occurring fish food by counting free-fall particles (Lasker and Brown, 1978).

Increasingly, microcomputers, rather than microprocessors, are being built into laboratory and field instruments because they can be programmed to handle variable situations including the changing of work performed by the instruments in response to changes in the factors being measured. For this reason, microcomputers are being employed in oceanographic data buoys (Lobecker et al., 1978), in unmanned underwater vehicles (Marine Industrial Advisory Service, 1980) and echo-sounder integration systems to estimate fish abundance (Kanemori and Ehrenberg, 1978; Iida and Susuki, 1980). Although these machines are programmable, they are essentially dedicated to one particular kind of task.

2.3 The General Purpose Microcomputer

Of greater significance to fisheries workers today is the availability of powerful, but relatively inexpensive, general purpose microcomputers. Sometimes they are called desk-top computers, but the largest reside in cabinets. Most are 8-bit machines (that is, they use eight binary digits consisting of either 0s or 1s to represent numeric data, alphabetic letters, and special characters), although 16-bit machines are becoming more common. Some of these microcomputers are capable of supporting several users whereas others only one user. The latter are called personal computers.

In the following paragraphs, I will state some of the advantages of personal and multiuser microcomputers, comment on available computer programming languages, describe several commercially available computer program packages, and end with some brief material on communicating with other computers and sensory instruments.

The great advantage of a personal computer is that it is available for immediate use at any time for nearly any application the user wishes. Unlike users of large computers, the personal computer user does not contend with slow response time of inability to gain access to the computer because too many users are on the system. Neither is the user of a personal computer subject to processing expenses or operator-imposed restrictions associated with large computers.

The multiuser microcomputer also has several advantages. Since such computers are usually dedicated to a small group of associated users rather than to some organization-wide support group, they are available for use at the convenience of the group. Computer programs and data sets can easily be shared. Peripheral devices, such as disks, a painter, and a graphics plotter can be shared, thus lowering the overall cost. Of course, only one user can utilize these paripherals at any one time.

BASIC is the most commonly used programming language, but many microcomputers can be programmed in several other high-level languages such as FORTRAN, COBOL and PL/I. In addition, several new structured programming languages, for example, Pascal, are becoming available for microcomputers. High-level languages allow the user to program the computer to perform almost any type of processing task imaginable.

Many new computer programs (or software) are becoming commercially available that significantly increase the utility of these machines to fisheries workers. Previously, software for data entry, file management and data-base management were available only on mainframe computers. Without such software for microcomputers, it was very laborious to enter data and manage the data sets for subsequent analysis. Now, there are several commercially available software packages for microcomputers that allow the user to set up data entry formats, manage individual data sets, or combine data sets or elements from several data sets for subsequent analysis. While these currently available packages are not as powerful as those for mainframe computers, they have significantly increased the usefulness of the microcomputer and the productivity of its users. With more powerful 16-bit microcomputers becoming available, this situation should improve.

Some statistical software packages exist for performing simple parametric and non-parametric analyses including time-series analysis. However, these packages generally are not very powerful because of limited machine memory, language-based restrictions on the number of significant digits that can be carried in calculations, and poor data entry and management procedures. Very few quantitative fisheries applications have been programmed onto microcomputers, but is should be fairly straight forward to do so. Again, with the entry of more powerful 16-bit microcomputers, more sophisticated statistical software should become available, and it should be possible to program all but our most complicated stock assessment methodologies onto these computers.

Most of the statistical software also have the ability to plot the data used in the analyses and the results from the analyses. Needs in the business world have resulted in software capable of producing pie charts and bar graphs, in color if you wish. Needs in the automotive, aircraft, and communication industries have resulted in the development of graphics software capable of displaying three dimensional charts, expanding views of selected areas of a display, rotating figures, and changing the angle of view. Thus, the available software is probably capable of handling any fisheries application; but the technology must be transferred to fisheries. Graphic representations of data can be displayed on monochrome or color video terminals or can be sent to graphics printers or plotters. The cost of these devices, particularly graphics printers, has decreased substantially the last couple of years, thus making them available to many more users. Relatively inexpensive color graphics printers are now available.

The microcomputer industry has created a unique type of software that has not as yet been implemented on larger computers. This software allows the user to set up a grid of columns and rows that can be mathematicaly interrelated according to the user's specifications. If the user wishes to see the consequences of changing some of the numbers entered into the spread sheet, he merely enters the new numbers and the rest of the table is recalculated. Thus, simple simulating can be programmed in minutes rather than hours using regular high-level languages.

The last type of microcomputer software that I will discuss, word processing, has tremendous utility in fisheries. Although this software accomplishes a task that is technically not part of fisheries or any science, word processing can reduce the time spent writing scientific documents. To produce this paper, I outlined what I wanted to say, collected information from the literature to supplement what I wanted to say, prepared a more detailed outline, and then sat down in front of a microcomputer and wrote the paper. The software allowed me to edit various sections, make insertions, and move whole sections around before I was satisfied with the document. When I passed the text file containing the document to the secretarial staff for finalization, they did not have to decipher cross outs, insertions, and arrows pointing in various directions. When they finished their work, I did not have to check for introduced typing errors. It is much easier and faster to prepare documents using word processing than by any other method. Word processing can be accomplished on micrcomputers, dedicated word processors, or mainframe computers, but these latter devices are less available to individual scientists.

Devices called modems and the software to support them allow the user of a microcomputer to communicate with other microcomputers or with mainframe computers. This facility essentially turns the microcomputer into a terminal which can then be used to transfer data sets to or from a mainframe computer and to conduct analyses directly on the larger computer. In addition, software is available for some microcomputers making it possible for them to function as a remote job entry station to a mainframe computer (27 80/37 80 protocol emulator). The capability of a microcomputer to emulate a terminal or a remote job entry station is extremely useful because it allows the microcomputer user to manage and process very large data sets on the mainframe computer and then use the microcomputer to process compacted data retrieved from the larger computer.

Most general-purpose microcomputers have the ability to interrupt ongoing processing and interrogate scientific measuring instruments, store or process the data received, and then return to the other task it was performing. Thus, the microcomputer can be used to control or conduct experiments while still being used as a data processing computer.

2.4 Comparing Microcomputers and Minicomputers

In the material presented above, I called the microcomputer a powerful tool and discussed some of its capabilities in terms of available software for data processing. To put things into perspective, I will compare specifications and costs for the basic hardware comprising a minicomputer and a microcomputer. For this comparison, I will use two tables listing the features of several minicomputers that were prepared by the International Commission for the Conservation of Atlantic Tunas (ICCAT) in 1978 and the Food and Agriculture Organization (FAO) Project for Tuna Management in 1980. The minicomputer procured by the Skipjack Assessment Programme of the South Pacific Commission (SPC) is included in these tables. The microcomputer used in the comparison is produced by Integrated Business Computers, a relatively small manufacturer in the US. Although this is a sophisticated system, it is not unique in the United States, Japan or Europe.

In 1978 the SPC acquired a Hewlett-Packard (HP) 1000 model 45 minicomputer to support their tagging activities. At the time, this computer represented the state of the art for mid-range minicomputers. In the same year, ICCAT prepared a paper comparing the capability and cost of several minicomputers (including the HP 1000) to the costs of time-share services from Computer Sciences Corporation's Information Network (Nordstom and Miyake, 1978). The hardware specifications and costs for the minicomputers are reproduced in Table 1. In 1980, FAO's Project for Tuna Management prepared a similar table comparing the features and costs of minicomputers for consideration by the tuna committees of the Indo-Pacific Fisheries Commission and the Indian Ocean Fisheries Commission (Skillman, 1980). By today's standards, these minicomputers (Table 2) no longer represent the state of the art, and they fall into the lower range of the capability of minicomputers.

It can be seen from Tables 1 and 2 that the cost of these systems has decreased substantially. In 1978, the cost of the basic HP system was nearly US$ 100 000. The least expensive system, the IBM, cost about US$ 88 000; the most expensive, Digital, cost US$ 106 000. By 1980, HP had become the least expensive system, costing only about US$ 58 000. The most expensive was the FACOM at over US$ 91 000.

From Table 3, it can be seen that the IBC microcomputer compares favorably with the minicomputers listed in Tables 1 and 2 in terms of central processor memory (its maximum memory is significantly less than the largest of the minicomputers, however), cycle time (a measure of internal speed; significantly faster than any of the minicomputers), and disk-storage capacity. The manufacturer's specifications did not give the density of the 9-track tape drive, but it is probably no more than 800 bits per inch (bpi), which is the same for the minicomputers listed in Table 1. Also, the disks may be slower than those used with minicomputers. Specifications are not the whole story, but this 8-bit microcomputer does compare reasonably well with the minicomputers listed.

For a number of years now, the 8-bit microcomputer has been dominating the market; however, the microcomputer field is undergoing a revolution because of the introduction of the 16-bit microprocessor. Today there are at least 20 microcomputers using these more powerful microprocessors. These new microcomputers are not only faster, but more importantly they can directly address much more memory (1.0 Mbytes or more as compared to 64 Kbytes). All or most of the minicomputers listed in Tables 1 and 2 are 16-bit machines. As the manufacturers of 16-bit microcomputers improve their products and make them more sophisticated, the 16-bit microcomputers will undoubtedly displace minicomputers of the level discussed here. In addition, two manufacturers have announced 32-bit microprocessors, and one indicated that manufacturing would start in 1983.

3. RECENT FISHERIES APPLICATIONS USING MICROCOMPUTERS

General purpose microcomputers are being used in fisheries to an increasing extent, including the Central and Western Pacific. As an illustration of this, I will present below the three recent applications.

3.1 Western Pacific Fisheries Information Network

With the passage of the Magnuson Fishery Conservation and Management Act in 1976, Federal and State fisheries managers have experienced an increasing need for data on fisheries resources in the US Fishery Conservation Zone. Accurate data are needed on a timely basis for management decisions and the preparation of fishery management plans. Managers and scientists in the National Marine Fisheries Service (NMFS), the Western Pacific Regional Fishery Management Council, and state and territorial fisheries agencies have encountered problems due to the lack of a historical data base, unavailability of existing data for analysis, legal constraints for data exchange, lack of data standardization, and inadequate procedures for data collection. The Southwest Fisheries Center started the Western Pacific Fishery Information Network project to solve these problems[1/]. Specifically, the purpose of the project is to (1) enchance and modernize the existing systems for fisheries information management and data collection; (2) develop and implement new systems for information management and data collection; (3) establish both central and distributed, computerized data bases; and (4) establish a communication network among state, territorial, and Southwest Fisheries Center data collection and processing groups for access to, and exchange of, the computerized data bases. The agencies included in the network are, in addition to the Honolulu Laboratory of the Southwest Fisheries Center, the American Samoa Office of Marine Resources, the Northern Mariana Islands Department of Natural Resources, Guam Division of Aquatic and Wildlife Resources, and Hawaii Division of Aquatic Resources.

The network is a distributed computer system consisting of a central minicomputer and satellite microcomputers (Figure 1). The central minicomputer system consists of a Digital Equipment Corporation PDP 11/70 accessed on a time-share basis using video display terminals or a microcomputer. The distributed microcomputer systems consist of Apple II Plus microcomputers each with twin 5-1/4 inch (13.3 cm) floppy disk drives, a dot matrix printer, and a video screen. Micromodems are included with the microcomputers located at the Honolulu Laboratory and the Hawaii Division of Aquatic Resources.

A similar network is being set up by the National Marine Fisheries Services' Southeast Fisheries Center for essentially the same purpose. This network will involve all the States in the southeastern US and will include data on fisheries resources under US jurisdiction in the Gulf of Mexico, the Caribbean, and off the southeast Atlantic coast.

3.2 Resource Assessments in the Indo-Pacific Region

The International Center for Living Aquatic Resources Management (ICLARM) is conducting several studies involving the assessment of demersal and pelagic fish stocks in Southeast Asia. Recently, Pauly (1981) indicated that they are establishing a microcomputer-based

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1/ Hamm, D.C., Preliminary description of the Western Pacific Fishery Information Network. 1982 Admin.Rep.Southwest Fish.Cent.NOAA/NMFS, (H-82-2):11 p.

system for filing trawl survey data on fisheries in the region and for their analysis by local scientists. In this same paper, Pauly also announced the availability of microcomputer software to calculate von Bertalanffy growth parameters and catch curves from length-frequency data.

3.3 Laboratory Research on Tuna in Hawaii

At the Kewalo Research Facility of the Honolulu Laboratory, microcomputers are being employed in experiments involving physiological parameters, environmental variables such as temperature, feeding preferences and rates, and electromagnetic fields. The microcomputers are interfaced with sensing devices to determine the movement and other bahavioural responses of captive animals being subjected to various experimental procedures. The microcomputers are programmed to analyse the bahaviour of the experimental fishes and alter the experiment in response to the fish's behaviour. In this way, the experimental animals' preference for environmental factors such as temperature have been determined. The ability of skipjack tuna, Katsuwonus pelamis, and other tuna to sense changes in the earth's electromagnetic field, is being investigated to determine their ability to use this environmental cue for migration.

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APPENDIX 1

Glossary

Analog. In the computer field, the use of electric voltages as physical analogues of numerical variables.

Architecture. Organizational structure of a computing system, mainly referring to the CPU or microprocessor.

BASIC. The most popular high-level language used on microcomputers. Short for "Beginner's All-purpose Symbolic Instruction Code".

Bit. An abbreviation of "binary digit"; single characters of a binary number, either 0 or 1 in the case of computers.

Byte (B). A sequence of n bits operated upon as a unit is called an n-bit byte. The most frequent size is 8 bits. KB stands for 1 024 bytes, and MB stands for 1 megabyte.

Bus. A group of wires that allow memory, CPU, and input/output devices to exchange data.

Clock. In a small computer, a device that sends out timing pulses to synchronize the actions of the computer.

COBOL. Short for "Common Business-Oriented Language"; a high-level language.

Computer Program (Program). A collection of instructions properly ordered to perform a particular task.

CPU (Central Processing Unit). That part of a computer system that controls the interpretation and execution of instructions. In general, the CPU contains the following elements: arithmetic-logic unit, timing and control, accumulator, scratch-pad memory, program counter and pointer stack, instruction register and decoder, parallel data and input/output bus, memory and input/output control.

Data Base. The entire collection of information available to a computer system. Or, a structured collection of information as an entity or collection of related files treated as an entity.

Data Base Management System (DBMS). Facilities for creating and maintaing a large, organized, structured collection of data and providing means for producing various types of predetermined reports based upon interrogation of the data base.

Data Set. A collection of data records, with a logical relation of one to another.

Digital. Of or pertaining to numerical bits.

Disk. A round piece of magnetic-coated material used to store data with greater density, speed, and reliability than with magnetic tapes. Floppy disks have thin 5-1/4 inch (13.3 cm) or 8 in. (20.3 cm) disks. Hard disks are thicker and can be much larger.

FORTRAN. A high-level language generally for scientific use, expressed in algebraic notation. Short for "Formula Translator".

Hardware. Physical equipment forming a computer system.

High-level Language. User-oriented programming languages using letters, symbols, or English-like text from which are generated codes the computer understands. FORTRAN, COBOL, and BASIC are three commonly used high-level languages.

Input-Output (I/O). General term for the process of communicating between the computer and external devices; or the data involved in that communication.

Mainframe Computer. A large-scale computer such as the IBM System 370 maxicomputer of a Digital VAX 11/370 minicomputer.

Memory. That part of a computer that holds data and instructions. Each instruction or datum is assigned a unique address that is used by the CPU when fetching or storing the information.

Microcomputer. A computer whose CPU is a microprocessor. A microcomputer is an entire system with microprocessor, memory, and input-output controllers.

Microprocessor. Frequently called "computer on a chip". The microprocessor is, in reality, a set of one, or a few, large-scale integrated circuits capable of performing the essential functions of a computer CPU.

Modem. Short for Modulator/demodulator. An electronic device that allows computer equipment to send and receive information through telephone lines.

Network. An interconnected group of computer systems, terminals, or communications facilities for sharing of data bases or computer processing resources.

Peripheral Device. Equipment that is external to the computer itself, for example, disks and printers.

Pascal. A high-level, structured programming language named after the 17th century French mathematician Blaise Pascal.

PL/I. A high-level, structured programming language combining features from COBOL, FORTRAN, and other languages. Short for "Programming Language One".

Software. Computer programs.

Terminal. An input-output device that interfaces between the human operator and the computer system, for example, a teletype or a video display terminal.

Video Display Terminal (VDT). A terminal containing a screen for viewing data entered into or received by the terminal. A cathode-ray tube is most commonly used resulting in the acronym CRT.

Table 1. Comparison of ICCAT's minicomputer performance and cost[1] (from Nördstrom and Miyake, 1978)

System models recommended	DIGITAL PDP-11 Model-34A	US$	HEWLETT-PACKARD 1000 Model 45	US$	IBM Series 1 Model E	US$	TEXAS INSTRUMENTS DS 990/10 Model 4	US$
HARDWARE								
Processor								
Memory	128K bytes		120K bytes		128K bytes		256K bytes	
Speed (cycle time)	725 n.s.				660 n.s.		725 n.s.	
Console	Printer (30 cps)		Screen		Screen		Screen	
I/O Devices								
Disks	14MB x 2		9.8MB x 2		64MB x 1		5MB x 4	
Av. access time	50.5 MS		33 MS		36 MS		35 MS	
Diskette magazine unit	—		—		28 MB		—	
Tape unit	800 BPI		800 BPI		—		800 BPI	
Printer	180 cps x 2		180 cps		150 l.p.m. (approximately 200 cps)		150 cps x 2	
HARDWARE COST:		103 367		—		77 271		91 560
SOFTWARE								
FORTRAN IV	Available		Available		Available		Available	
Utilities and sort	Available		Available		Available		Available	
SOFTWARE COST:		2 338				10 656		5 550
TOTAL PRICE		105 705		99 989		87 927		97 110
OPTIONAL								
Processor								
Memory	Up to 248KB		Up to 2MB (by unit of 128K)	8 071/128K	Up to 256KB	11 743	Up to 2MB	
Card reader	300 c/m	9 500	600 c/m	10 291	Not available		400 c/m	7 800
V D U (Screen)			Available	5 246	Available		Available	
Plotter	Not available[2]		280 x 400 mm	7 743	Not available[2]		Not available[2]	
Software (Data base managing system)	DATATRIEVE-11	6 493	IMAGE/120	4 571	Not available at present		Available	3 000

[1] Estimates for prices are valid for October-November 1978. Prices are given in pesetas and converted into US$.

[2] Any makes can be adopted.

Table 2. Comparison of minicomputer performance and cost (from Skillman, 1980)

System/Models Specifications	DEC PDP-11/34A	US$	FACOM V-830	US$ 6/	HEWLETT-PACKARD HP 1000, Mod 45	US$	IBM Series 1, Mod E	US$	Texas Instruments TI990/10 Model A	US$	Wang Model 2200 VS	US$
Basic configuration												
Central processor												
Memory	128K	n/c	262K	n/c	128K	n/c	128K	27 200	256K	n/c	128K	n/c
Speed (cycle time)	725 n.s.		400 n.s./2B		420 n.s.		660 n.s.	(operating system)	725 n.s.		660 n.s.	
								2 000				
Console	printer 30 cps	n/c	screen	n/c	graphics screen	n/c		1 700	screen	n/c	screen	n/c
Cost		54 000		45 700		43 500		30 900		34 500		21 800
Peripherals												
Main storage	disk 28MB (x2)	n/c	disk 40MB	n/c	disk 19.6 MB (x2)	n/c	64MB x 1	10 700	disk 5MB (x4)	7 800	disk 75MB (x4)	19 000/ unit
Backup storage	tape 1600bpi	17 000	disk 40MB(x4) tape 1600bpi	9 400 22 800	tape 800bpi	10 750	tape	17 500	tape 800bpi	10 000	tape 800/ 11600bpi	16 100
Printer	180 cps(x 2)	7 400	180 cps	9 582	180 cps	4 000		8 600	150 cps(x 2)	5 500	220 cps	10 350
Cost		24 400		41 782		14 750		36 800		23 300		45 450
Software												
FORTRAN IV	available	800	available	75/mo.	available	n/c	available 2/	870	available	1 000	available	n/c 3/
Utilities and sort	available	n/c	available	165/mo.	available	n/c	available	720	available	2 500	available	n/c
COBOL	available	?	available	75/mo.		n/a	available	870		n/a	available	3 450
Cost		800				0		2 460		3 500		3 450
Total cost		79 200		91 262		58 250		70 160		61 300		70 700
Options												
Memory up to	256K	4 000	512 KB	3 600/ 128KB	2 MB in 128K	3 500/ 128K	256K	1 510/ 16KB	1 MB	575/ 4Kwords	512K for VS 2 048K for VS 100	8 500/ 128K 10 350/ 128K
Card reader	300 c/m	7 000	600 c/m	17 030	600 c/m	6 375		n/a	400 c/m	5 200		n/a
Video display screen	available	2 200	available	3 862	available	3 500		n/a	available	2 000	available	2 900
X-Y plotter		n/a		n/a		2 600		n/a		n/a	not now available	
Data Base Software		4 500	available	200/mo.		3 000		n/a		2 000	available 4/	n/c
Word Processor Software											available 5/	3 000

1/ Cost estimates were quoted by west coast vendors in U.S.A. and may vary withthe site chosen in Indo/Pacific area.

2/ PL/1 language is also available.

3/ BASIC and PL/1 languages also available; Assembler and one higher order language included with price of system and each additional language cost $3.450.

4/ An advanced DBMS is available for $17 250.

5/ Word processor terminal (CRT) cost $4 376.

6/ CIF Manila

Table 3. Specifications, performance capability, and cost of an IBC Ensign Model E-1256 microcomputer

Specifications	Values	Cost US$
Basic configuration		
Central processor		10 850
Memory	256K	n/c
Speed (cycle time)	120 nsec	--
Console	Video	1 300
Subtotal		12 150
Peripherals		
Main storage	2, floppy disks (2.4MB	n/c
	Winchester disk (50MB)	8 200
Backup storage	9 track tape drive	2 250
Printer	150 cps	1 695
Subtotal		12 145
Software		
Basic	Available	290
COBOL	do	580
FORTRAN	do	350
Pascal	do	430
PL/I	do	460
Operating system cp/M	4 different systems	300
Subtotal		2 410
Total		26 705
Options		
Memory up to	768KB	4 200/256KB
Card reader	Not available from manufacturer	
Video display terminals	3 models	800 to 1 300
X-Y plotter	Available from other vendors	
Data base software	do	
Word processor software	do	

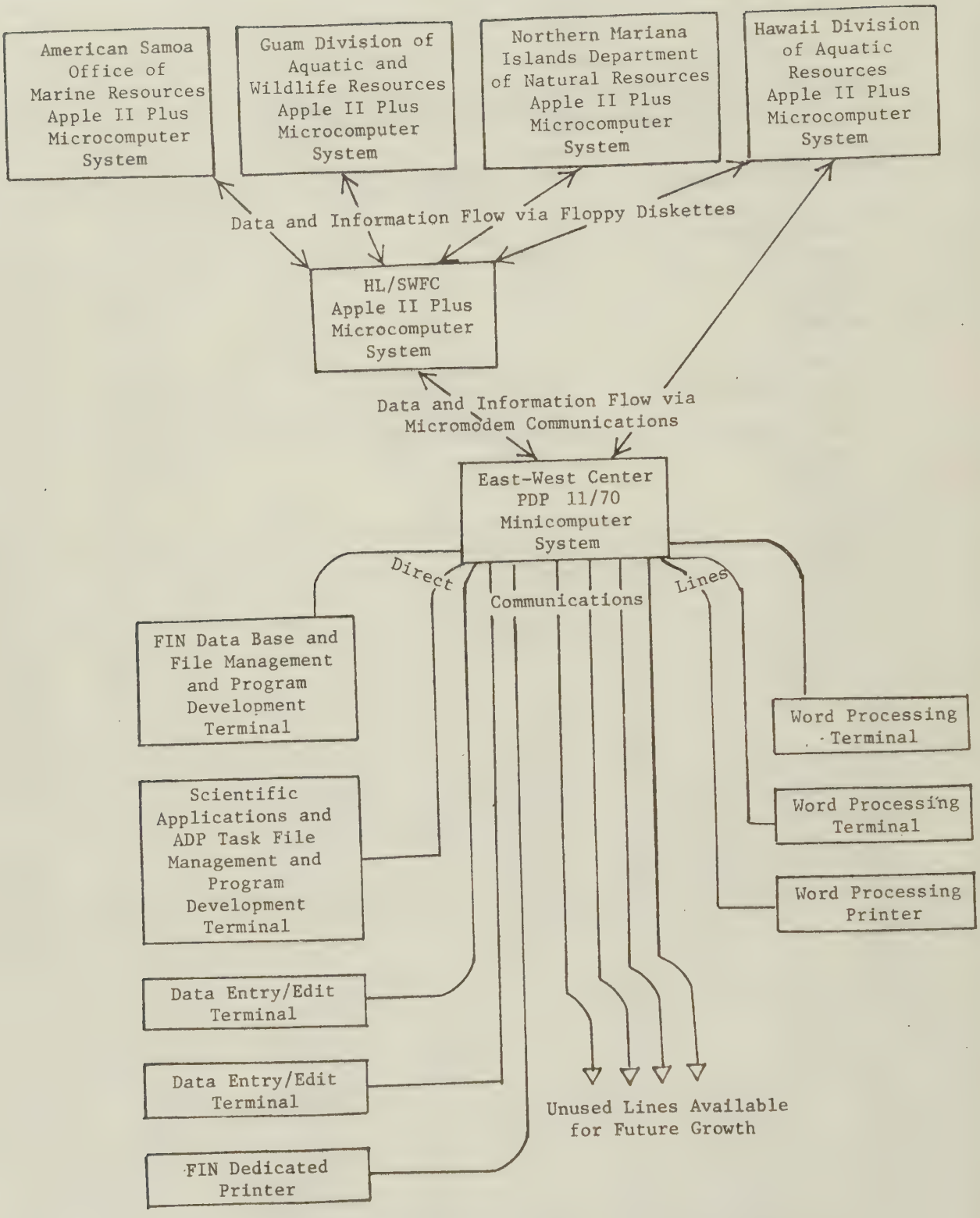
American Samoa Office of Marine Resources Apple II Plus Microcomputer System
Guam Division of Aquatic and Wildlife Resources Apple II Plus Microcomputer System
Northern Mariana Islands Department of Natural Resources Apple II Plus Microcomputer System
Hawaii Division of Aquatic Resources Apple II Plus Microcomputer System
Data and Information Flow via Floppy Diskettes
HL/SWFC Apple II Plus Microcomputer System
Data and Information Flow via Micromodem Communications
East-West Center PDP 11/70 Minicomputer System
Direct
Communications
Lines
FIN Data Base and File Management and Program Development Terminal
Scientific Applications and ADP Task File Management and Program Development Terminal
Data Entry/Edit Terminal
Data Entry/Edit Terminal
FIN Dedicated Printer
Word Processing Terminal
Word Processing Terminal
Word Processing Printer
Unused Lines Available for Future Growth

Figure 1. The WPACFIN hardware configuration (see text footnote 2)

ANNEX 5

National Reports on Squid Fisheries

SQUID AND CUTTLEFISH RESOURCES OF AUSTRALIAN WATERS

by

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1. INTRODUCTION

Cephalopods of various kinds have long been taken by Australian coastal fishermen, (Winstanley, in press). Major increases in production seen since the mid-1970 s have been the result of Taiwanese and, to a lesser extent, Korean demersal trawling in northern waters and the intermittent activity by Japanese and Taiwanese squid-jigging vessels off the southern coast. (Liu, H.C., H.L. Lai and S.Y. Yeh, 1978; Harrison, 1979). Commercial species of Australian waters are listed and a summary of the catch from the various fisheries presented in Tables 1 and 2.

This increased interest has allowed the broad identification of species with commercial potential. However, any assessment of the size and extent, geographically or seasonally, of the exploitable resource in any region, would, with our present knowledge, only be preliminary. Data collection from local and foreign fisheries has been inadequate and only recently has any research been directed specifically toward squid in Australian waters. A solid foundation of biological information is essential to responsible assessment. For all species mentioned in this report, major gaps still exist in our understanding of their basic biology (Wilson, 1981).

The Australian domestic market for squid is comparatively small (estimated at 2 600 t in 1978-79) but growing rapidly. Although production from all sources in our waters greatly exceeds this amount (> 10 000 t in 1979-80), most finds its way to the home markets of the foreign fishing nations mentioned previously. Indeed some 75 percent of squid consumed in Australia is imported from Southeast Asia (Taiwan and Thailand). California and New Zealand (1 321, 317 and 176 t respectively in 1979-80) at much lower cost than is paid for Australian product (Anon., 1980a).

2. SOUTHERN SHELF SPECIES

2.1 Nototodarus gouldi

The principal commercial species is Nototodarus gouldi McCoy, an ommastrephid closely related to the Japanese common squid Todarodes pacificus Steenstrup. Its known distribution extends from southern Queensland around the southern coast to Shark Bay in Western Australia (Lu and Dunning, in prep.). Although the species occurs from close inshore to the upper continental slope, analysis of the available catch data shows the adults to be most abundant in waters from 40 to 90 m (Fisheries Division, 1981). N. gouldi rarely exceeds 40 cm mantle length and has, on the basis of recent collections of larvae and juveniles in the Bass Strait region, a protracted spawning season throughout the summer. (Machida, pers. comm.; CSIRO, unpublished data).

Exploratory and joint-venture fishing for this species has been undertaken intermittently during the summer months by Japanese jigging vessels since 1971-72. During the first season of joint-venture fishing (1978-79), 19 vessels took 3 400 t from Bass Strait (Figure 1). In the following year, 64 Japanese vessels took 8 000 t of Nototodarus from the same region between late December and early May, confirming that an exploitable resource existed in these waters. A further 32 vessels fished off southwest Western Australia during this same period but produced a disappointing catch of only 400 t (Fisheries Division, 1980).

Principally the by-catch of demersal trawl fisheries in New South Wales, Victoria and Tasmania, the annual Australian catch of Nototodarus passing across the market floor was approximately 300 t (Table 3). However, an unknown quantity is sold through other avenues (Fisheries Division, 1981).

Most Nototodarus caught by the Japanese was sold on their home market and with the exceptionally good Todarodes and Illex season in 1980 (in Japanese and North Atlantic waters respectively), and with increasing oil prices the profitability of Australian fishing venture disappeared, (Hokkaido Reg.Fish.Res.Inst. 1981). Consequently, no full-scale commercial-jig fishing for this species has taken place in our waters since May 1980.

2.2 Sepioteuthis australis

Sepioteuthis australis Quoy and Gaimard, a temperate loliginid, attains a similar size to Nototodarus. Although its distribution around the coast parallels the latter, it inhabits mainly inshore waters, bays and inlets and is rarely encountered in waters deeper than 100 m (Winstanley, in press).

It is also a component of southeast Australian demersal trawl fisheries but is more commonly taken by local fishermen with troll lines, handjigs and set nets in shallow water. Approximately 300 t are sold on the domestic market annually with the majority (approx. 150 t) coming from South Australian waters (Smith, 1980) (Figure 1).

2.3 Cuttlefish

Although cuttlefish of various species (including Sepia apama Gray, S. Hedleyi Berry and S. rex Iredale) are commonly seen in fish markets along the southern coast (Lu, pers. comm.), few details of quantities of each species sold or of their origin are available.

Total reported production for New South Wales for 1978-79 was 132 t and for Victoria 14 t. (Anon., 1979; 1980b). Much is presumably by-catch of prawn and mixed species trawl fisheries in shallower inshore waters. No biological information is available for these species.

3. NORTHERN SHELF SPECIES

3.1 Loliginid Squid

The most important commercial group in this region are loliginids. Common species include Sepioteuthis lessoniana Lesson, Loligo bleekeri Keferstein, and several species best considered as members of two "complexes", Loligo edulis Hoyle with two forms and L. chinensis Gray-singhalensis Ortmann. The taxonomic status of these species is currently under investigation (Lu, pers. comm.). These include larger forms equal in size to their southern counterparts (S. lessoniana, L. singhalensis and L. edulis (large form) and small forms maturing at less than 15 cm mantle length (L. edulis (small form), L. chinensis). Squid are abundant in the Gulf of Carpentaria and Arafura Sea (Figure 1) throughout the year according to Taiwanese trawl data but are of lesser importance on the northwest Shelf, (Demersal Fish Research Center, 1979; 1980). Preliminary studies suggest that S. lessoniana and L. chinensis are common off the Queensland coast although available catch data is inadequate to reveal any clear distributional patterns. (Potter, pers. comm.). Although life history studies of S. lessoniana have been undertaken elsewhere, our knowledge of the biology of the remaining species is fragmentary. (Rao, 1954; Oommen, 1977).

Korean and Taiwanese trawlers, now in joint venture with Australian companies, have been exploiting this resource since the mid-1970 s (Liu et al., 1978). While it had been largely unrecognized in assessments made prior to Australia's 200-mile zone declaration, in 1979 (Australian Fisheries Council, 1977), the Taiwanese fishery has yielded 2 000-3 000 t annually (Table 4). The Korean catch before 1980 remains unknown but is believed to have been much smaller. All foreign-caught squid is marketed in the vessels country of origin.

Australia's northern prawn fleets have recently begun to utilize the squid by-catch. In excess of 100 t of frozen product from Exmouth Gulf in Western Australia is sold on the domestic market annually. A similar quantity is taken from the eastern Queensland coast (Fisheries Division, 1981; Potter, pers. comm.).

3.2 Cuttlefish

Sepiids, mainly Sepia pharaonis Ehrenberg, according to limited research catches, tend to replace loliginid squid as the principal cephalopod component in Taiwanese trawl catches on the Northwest Shelf and in the Timor Sea (Table 4). Approximately 600 t are taken from the region annually. However, we have no information regarding species composition of commercial catches, size distributions or other aspects of the biology of these species.

4. OCEANIC SPECIES

4.1 Ommastrephid Squid

Although they are not presently exploited within the Australian Fishing Zone, three oceanic ommastrephid squid are known to be abundant in temperate subtropical and tropical waters of the Tasman and Coral Seas. (JAMARC, 1980; Dunning, Potter and Machida, 1981). Soviet biologists also record them from similar environments off the west coast. (Nesis, 1979).

Todarodes filipprovae Adam was caught in commercial quantities off northeast Tasmania in 1978. The species which is common in the subtropical convergence zone of the Southern Ocean grows in excess of 50 cm ML. (Okutani, 1980).

Ommastrephes bartrami Lesurer is a subtropical surface schooling species which grows in excess of 50 cm ML and is the object of major driftnet and jig fisheries in the North Pacific. (Hokkaido Reg.Fish.Res.Inst., 1981).

Its somewhat smaller tropical counterpart, Symplectoteuthis oualaniensis Lesson is commercially jigged off southern Taiwan and Okinawa (Okutani, 1977; Young, 1975).

4.2 Other Squid

Thysanoteuthis rhombus Troschel is a tropical cosmopolitan species which has been recently encountered during research cruises in the Coral Sea. Growing to more than 80 cm ML, this species is commonly taken by baited hook in southern Japanese waters.

Incidental trawl catches of Enoploteuthis galaxias Berry in deep-water off Sydney, suggest that this small species may be abundant here. If is closely related to Watasenia Scintillans Berry, fished in Japanese waters using set nets (Okutani, 1977).

Whether any of the above species occur regularly in Australian waters in commercially exploitable concentrations remains to be determined. At present no ocean-going Australian vessel capable of conducting the necessary research is available.

Other mesopelagic squid are also abundant off both the east and west coasts but are unlikely to attract commercial interest because of their size or suitability for human consumption.

5. COLLECTION OF FISHERIES STATISTICS

5.1 Southern Shelf Waters

During the two seasons of feasibility and joint-venture fishing in Bass Strait for Nototodarus mentioned previously, details of the catch of each commercial vessel were recorded daily on logforms (Appendix A). Concurrently, exploratory jig fishing in Bass Strait was carried out by a Japan Marine Fishery Resource Research Centre (JAMARC) vessel

which conducted more detailed biological examination of catches taken in this region in cooperation with South Australian, Victorian, Tasmanian and Commonwealth authorities. This research was also udertaken between December and April in 1977-78 and in 1980-81 (JAMARC, 1978, 1980a, b). Indications of size structure of the commercial jig catches are available from the numbers of boxes of each "grade" of squid caught. Length frequency analyses undertaken by the JAMARC vessel confirmed the accuracy of this data (Harrison, 1979). This data set, however, has several severe shortfalls:

(a) data have been collected for only two seasons by different fleets operating in new fishing grounds;

(b) no data were collected in the same region at other times of the year;

(c) vessels were only allowed to operate within restricted areas which were not the same in both seasons;

(d) only the research data were obtained over a wide area with commercial fleets concentrating on areas of abundance encountered early in the season. Because the commercial fleets work as units of several vessels, it is difficult to compare their catch rates with those of a single research vessel;

(e) data was obtained only by jigging which may be a biased sampler of the total population.

No data has been collected from Bass Strait since the last JAMARC research cruise in March 1981.

Similar data to that obtained in Bass Strait is available from the feasibility and joint-venture operations conducted in southern Western Australian waters in 1979-80. However, no squid research vessel has operated in these waters at any time.

In response to the incidental trawl catches of Nototodarus in southern New South Wales waters taken by the State Fisheries research vessel, she was re-equipped with automatic jigging machines and commenced an exploratory fishing study in late 1980. Work has been limited to summer sampling but will be extended to cover a greater proportion of the New South Wales coast in 1982. Length frequency information and reproductive condition are being recorded which it is hoped can be correlated with similar biological details obtained from demersal and midwater trawl catches.

It is clearly necessary to correlate the information already held by the various organizations and to accumulate more biological information about Nototodarus in southern Australian waters throughout its range and during all seasons of the year. Then an appropriate survey design, perhaps similar to the grid system adopted by the Japanese to assess stock sizes of Todarodes pacificus, could be used to accurately assess the abundance of this species (Kasahara, 1978).

5.2 Northern Shelf Waters

Catch data have been available from the Taiwanese demersal trawl fishery since the early 1970 s. Until the AFZ declaration in late 1979, it was of the form of total squid and cuttlefish catch by half degree square for each three-month period (Demersal Fish Research Center, 1979; 1980). With the logbook system which now operates (Appendix B), daily records are available but still without differentiation of species. These data are also biased because different fishing gear and fishing strategy are used in areas of historical squid abundance. In some areas, squid are the target species while elsewhere they represent part of the by-catch only. (Liu, H.C., H.L. Lai and S.Y. Yeh, 1978). Because logbooks are not maintained by domestic prawners and fish trawlers, no information other than total production in a broad geographic region is available from these vessels.

Before any accurate assessment of squid and cuttlefish resources within these waters can be undertaken, it is necessary to obtain detailed catch composition data from all vessels utilizing the resource. When the biological characteristics of each species throughout its range are better known, it will be possible to design the appropriate surveys which will yield the necessary information for responsible assessment.

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Table 1

Commercial squid and cuttlefish of Australian waters

Area	Species	Commercial fishery (A = Australian F = Foreign vessels)
Southern shelf waters		
Squid:	Nototodarus gouldi	A,F
	Sepioteuthis australis	A
Cuttlefish:	Sepia apama	A
	S. rex	A
	S. hedleyi	A
Northern shelf waters		
Squid:	Loligo edulis	F,A
	L. chinensis	F,A
	L. singhalensis	F
	L. bleekeri	F
	Loliolus sp.	?
	Sepioteuthis lessoniana	F
Cuttlefish:	Sepia pharaonis	F
Oceanic waters		
Squid:	Ommastrephes bartrami	-
	Todarodes filippovae	-
	Symplectoteuthis ovalaniensis	-
	Thysanoteuthis rhombus	
	Enoploteuthis galarias	-

Table 2

Cephalopod fisheries by geographic area

Area	Years of the fishery	Annual catch (in t)
Southern shelf waters:		
Large-scale jigging	1978-80	3 400-8 500
By-catch of demersal trawling. Troll lines set nets in shallow water	to present	est. 600 (1979-80)
Northern shelf waters:		
Demersal trawling	1971 to present	3 300 (1979)
By-catch of prawn trawling	? to present	est. 200 (1979-80)
Oceanic waters:		
	no commercial fishery	

Table 3

Australian domestic squid production by state (catch in t)

Year	NSW	VIC	QLD	SA	WA	TAS	NT	Total
1974-75	NA	52	106	36	12	6	-	212
1975-76	19	60	90	52	28	1	1	253
1976-77	32	61	82	59	36	6	4	280
1977-78	48	53	120	102	54	2	3	381
1978-79	136	82	113	146	29	73	4	583
1979-80	194	107	100[a/]	193	140	120	-	854
1980-81	255	85	NA	113	NA	NA	NA	NA

a/ Estimated (Potter, pers. comm.)

Table 4

Taiwanese cephalopod catches from northern Australia

	N.W. Shelf	Timor Sea	Arafura Sea	Total (t)
A. Squid				
1978[a/]	103	9	1 714	1 836
1979[a/]	88	33	2 629	2 720
1980[b/]	42	20	310	372
1981[b/]	(45)	(0)	(404)	(449) incomplete
B. Cuttlefish				
1978[a/]	429	28	100	557
1979[a/]	448	15	129	592
1980[b/]	285	16	47	348
1981[b/]	(26)	(3)	(28)	(291) incomplete

a/ Data from Demersal Fish Research Center (1979; 1980)

b/ Data from Australian Department of Primary Industry logbooks (The low catch in 1980 is a probable reflection of change in fishing arrangements after the AFZ declaration in November 1979. 1981 data is for the first 6 months of the year)

FIGURE 1.

INDONESIA
PAPUA NEW GUINEA
SOLOMON SEA
SOLOMON ISLANDS
TUVALU
CORAL SEA
SOUTH PACIFIC OCEAN
TIMOR SEA
INDIAN OCEAN
AUSTRALIA
NORFOLK IS
TASMAN SEA
NEW ZEALAND
TASMANIA
SOUTHERN OCEAN
MACQUARIE IS
Principal fishing areas
Sepioteuthis australis
Nototodarus gouldi
Lologinids and Sepiids
200 NAUTICAL MILE
AUSTRALIAN FISHING ZONE
1 November 1979

THE HONG KONG SQUID FISHERY

by

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1. SPECIES OCCURRING

Ten species of squids have been recorded around Hong Kong. Among these, Loligo edulis, L. formosana, L. duvaucelii, Doryteuthis singhalensis and Sepioteuthis lessoniana are of commercial importance. In particular, L. edulis and L. formosana are the most widespread and common species occurring between the 30- and 170-metre contours within the continental shelf areas. The other species are L. tagoi, Nototodarus sloani philippinensis, Todarodes pacificus, Symplectoteuthis oualaniensis and Cranchia scabra.

2. FISHERY

In 1980, the total landing of cephalopods in Hong Kong was 6 067 t, in which 4 104 t were squids (67.7%), 1 814 t cuttlefish (29.9%) and 149 t octopus (2.4%). The landing of squids, during the past ten years (1971-80), has increased more than two-fold from 2 357 t in 1971 to 6 139 t in 1979 (Table 1). The landing is largely composed of the two dominant species, L. edulis and L. formosana, which are caught mostly by pair and, to a lesser extent, by stern trawlers. It is difficult to ascertain the existing status of directed fisheries for squids in Hong Kong as the trawl fishery is a mixed species fishery. Squids only comprised an average of 2.7% of the total landings of all marine capture within the past ten years. However, it is noted that the landing of squids in the third quarter of the year (July - September) reaches 16.1% (average 1974-80) of the total modern pair-trawler landings. Most of the catch is from the shelf fishing areas II (13.2%), IV (66.2%) and V (14.8%) (see chart of fishery areas in report of stock assessment studies in Hong Kong). Some trawlers, particularly modern pair trawlers, concentrate on catching squids from the continental shelf areas off Guandong (shelf areas II, IV and V) during the period July-September when squids are most abundant as evidenced by the catch per unit effort data (Table 2; Figure 1). The exact extent of the directed effort, however, is not known since no specific survey of the squid fishery has been conducted. Seme less commercially important species, such as Loligo duvaucelii and Sepioteuthis lessoniana, are caught in coastal bays during May-September by purse seiners.

Landings of squids in Hong Kong show both seasonal and annual changes. Figure 1 illustrates the catch per unit effort estimated for squids by seasons over the past six years. A high abundance value is recorded in the third season, i.e., from July to September. This high abundance could be a result of spawning and recruitment to the squid population at this time. The change in annual landings, however, seems to follow a three/four year cycle (Table 1). It is also noted that the annual landings show an increasing trend from 1966 to 1980.

3. MARKETS AND TRADE

Squids landed by Hong Kong vessels are mostly sold at wholesale markets operated by the Fish Marketing Organization. In 1980, squids worth HK$ 41.1 million were landed, an increase of nearly five-fold within the past 10 years (HK.$ 8.6 million in 1971). Most of the catch is for local consumption and only about 2.1% of the landing is for exports to countries such as USA, Canada and Japan. Table 3 summarizes the trade statistics of squids in Hong Kong from 1971 to 1980. The exports of various forms (fresh, frozen, dried or salted) of squids in terms of percent weight of local landings have remained fairly steady over the past 10 years. The value of the export trade varied from HK.$ 1.9 million in 1974 to HK.$ 32.2 million in 1979. Imports of squids from other countries (i.e., Thailand, Singapore, Canada, China, Taiwan, the Philippines and Viet-Nam have increased from 459 t in 1971 to 3 696 t in 1980, with trade worth over HK.$ 44.9 million at the present moment. Most of the frozen squids imported to Hong Kong are used as bait for longline fishing. Some of the imported squids are also re-exported to other countries. The re-export trade, however, shows a decline since 1974

from 65.3% of the total imported squids to only 7.0% in 1980. This may reflect the increasing demand for consumption of various forms of squids in local markets. From data obtained in 1971 to 1980, it appears that Hong Kong fishing vessels supply an estimated 77.9% of the total demand (an average of 5 599 t over past 10 years) of squids which are required annually for consumption and exports.

4. RESEARCH

Statistics of catch and effort data for squid fishery are being collected within an on-going research programme for monitoring the overall catch and effort data of the trawl fishery in Hong Kong (see Table 2). In addition, data on length/size frequency of individuals are occasionally obtained from catch statistics of the research vessel.

5. ASSESSMENT OF SQUID RESOURCES

No direct attempt has been made to assess squid resources around Hong Kong. However, catch per unit effort statistics are available from the on-going catch and effort data monitoring programme of the trawl fishery.

Table 1

Local landings of squids in Hong Kong (1971-80)

Year	Tons	Million HK.$	Cost (thousand HK.$) per ton
1971	2 357	8.5	3.6
1972	3 656	10.4	2.8
1973	3 017	12.3	4.0
1974	3 268	13.4	4.1
1975	4 844	18.0	3.7
1976	6 089	24.3	4.0
1977	4 202	24.5	5.8
1978	5 002	28.2	5.6
1979	6 139	43.8	7.1
1980	4 104	41.1	10.0

Table 2

The catch per unit effort (kg/1 000 m (HL).HP.Day) for squids in Hong Kong in 1980 by trawlers according to fishing areas (for areas see section on assessment methods in Hong Kong)

	1980			
Area	Jan.-March	Apr.-June	July-Sept.	Oct.-Dec.
I	0.23	0.44	0.62	0.07
II	0.89	1.75	5.17	2.41
III	0.42	0.69	1.92	2.02
IV	1.14	1.34	4.85	2.65
V	1.56	2.39	8.63	2.52
VI	0.01	0.02	0.01	0.01

Table 3

The trade statistics of squids in Hong Kong (1971-80)

Year	IMPORTS			EXPORTS			RE-EXPORTS		
	Tons	Million HK.$	% weight of FMO landings	Tons	Million HK.$	% weight of FMO landings	Tons	Million HK.$	% weight of imports
1971	459	2.0	19.5	70	9.1	2.9	51	0.2	11.1
1972	893	3.4	24.4	60	7.7	1.6	78	0.5	8.7
1973	536	5.0	17.7	49	6.2	1.6	111	1.1	20.7
1974	955	8.4	29.2	21	1.8	0.6	624	8.6	65.3
1975	802	8.9	16.5	136	11.4	2.8	327	4.1	40.7
1976	1 023	9.4	16.8	78	6.5	1.2	215	4.1	21.0
1977	1 011	9.1	24.0	81	8.3	1.9	265	5.4	26.2
1978	1 525	19.5	30.4	82	9.2	1.6	383	12.0	25.1
1979	2 415	51.6	39.3	234	32.2	3.8	282	10.3	11.6
1980	3 696	44.9	90.0	107	18.6	2.6	258	6.6	7.0

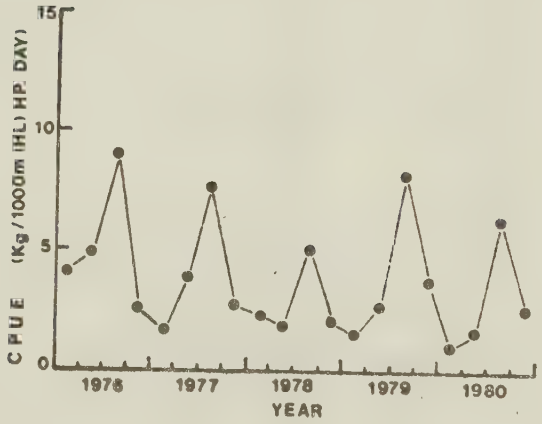

Figure 1. Catch per unit effort for squids (by trawlers) by quarters (seasons) of year (Area II, IV and V)

REMARKS ON THE CEPHALOPOD RESOURCES OF INDIA

by

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1. TOTAL CATCH OF CEPHALOPODS

Total catch in India varied from 94 t in 1961 to 11 336 t in 1980. Separate estimates of catches of squids are not available. Size ranges of different species of cephalopods at important centres and their percentage composition in total catches were recorded. In 1979, the catch rates of cephalopods varied from 0.3 kg/h to 4.5 kg/h in trawl nets.

2. SPECIES COMPOSITION

Important species include:

Squids:
(1) Loligo duvaucelii
(2) Doryteuthis singhalensis
(3) Sepioteuthis lessoniana
(4) Sepioteuthis arctipinnis

Cuttlefish:
(1) Sepia aculeata
(2) Sepia pharaonis
(3) Sepia elliptica
(4) Sepiella inermis

Octopi:
(1) Octopus herdmani
(2) Octopus globosus

3. FISHERY

Landings of cephalopods are mostly obtained from shrimp trawls. They are also caught in small quantities in boat seines, shore seines and on hooks and lines. S. arctipinnis contributes to a seasonal fishery in the Palk Bay region by shore seines. Maximum catches of cephalopods are landed in the state of Kerala, followed by Tasmil Nader and Maharashtra. West coast of India accounts for 60-70% of the catches.

4. UTILIZATION

In India only squids are relished as food. However, cephalops constitute a potential resource for export in frozen condition. Cuttle bones are also exported to other countries.

Note: All the available data on cephalopod resources of the country are being documented by the Central Marine Fisheries Research Institute, Cochin.

A SMALL-SCALE SQUID FISHERY IN ALAS STRAIT, WEST NUSATENGGARA

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1. INTRODUCTION

Cephalopod resources can be found anywhere in Indonesian waters. They are caught by different kind of fishing gear and are marketed fresh, frozen or salted and sundried. Three commonly known cephalopod groups are squid, locally popular as "cumi-cumi", cuttlefish of "ikan nus" and octopus commonly called "gurita".

Total catch for 1979 was reported to be approximately 12 000 t of which squid and cuttlefish were the most important items. In most of the vast Indonesian waters cephalopod landings are considered as by-catches and no serious efforts are being made to upgrade the data concerned. Both squid and cuttlefish landings come from coastal small-scale fishing operations while octopus is limited to coral reef waters. Reports by research vessels mention the abundance of high sea or oceanic big squids along the Indian Ocean coastal waters, but so far no commercial landings have been recorded yet.

Based on the above 1979 total landing, areas with more than 1 000 t catch include Malacca Strait, Java Sea, South Sulawesi and West Nusatenggara. A rather specialized operation for squid found in the last area is concentrated in Alas Strait, one of the straits of Nusatengara islands chain separating Lombok and Sumbava islands. Total landing in 1980 from this area was reported 1 722 t.

2. THE ALAS STRAIT SQUID FISHERY

Alas Strait is located between Lombok and Sumbawa linking the Flores Sea to the north and the Indian Ocean to the south and the average depth is approximately 70 m. Labuanhaji, the centre of squid landings and base of the squid fishing fleet is located, on a bay on the Lombok coast, facing the Alas Strait. Light fishing is the major occupation of the local fishermen and an encircling net with a cod-end locally called as "jala oras" is the common fishing gear in this fishery. This type of net was the original oil sardine net widely used in Bali Strait before purse seining was introduced. Fishing boats operating for squids are wooden boats with lengths varying from 5 to 7 m. Each of them is accompanied by a very small boat ranging from 1 to 1.5 m in lenght, functioning as the light boat which is carried on board the catcher on its way to the fishing ground and back to the landing place.

Squid fishing is only done during the west-monsoon from September up to February or March and is of course limited during the dark moon only. The number of boats has increased continously and reached 600 in 1980. Total landing has also increased every year as shown in Table 1.

Table 1

Annual squid landings in Alas Strait 1975-80 (in t)

1975	612
1976	1 820
1977	1 223
1978	1 466
1979	1 546
1980	1 722

Source: West Nusatenggara Fishery Service

Unlike other areas where landings are usually a mixture of squid and cuttlefish, the Alas Strait landings are consisting almost of only squid. Landings of cuttlefish in Malacca Strait and Java Sea are much higher in percentage where riverine out-flow have a big influence in both waters.

Most of the catches are not consumed locally but are salted, sundried and transported to Java.

Considering the limited area of fishing and possibly also a limited stock of squid, while the number of boats is continuously increasing most fishermen acknowledge the critical situation and based on a sociological approach control of efforts is introduced by limiting the number of kerosene lamps used for each operation by individual boats.

During the east-monson with peaks in July or August, fishermen change their activities to trolling for skipjack, yellowfin and small tunas.

3. IDENTIFICATION OF SQUID SPECIES

Obviously no studies on the inventory of cephalopod of Indonesia had been undertaken except by short visiting scientists interested in this field. Young scientists from several institutions are being recruited to develop systematic studies on cephalopod but, lacking in guidance and literature availability not only for squid or cuttlefish but for most invertebrates (marine), these activities cannot be accelerated properly.

Still concentrating in Alas Strait preliminary works on identification of squid is associated with a sampling program conducted in this area, and studies on materials collected from landings show that the most common species is Loligo edulis.

4. FUTURE WORKS

The importance of all three groups of cephalopods in the development of the Indonesian fishery is becoming significant. Starting recently experimental canning of squid has been done in Bali Strait by one of the prominent sardine canners and, although still on a small-scale basis, export of squid has just commenced from North Sumatra (Malacca Strait). And along the lines with the increasing demand for seafood generally squid, cuttlefish and octopus are accepted as high-quality commodities. In view of the need for research to support the development of squid fishery in Indonesia, directions are being studied to carry out necessary actions including:

- to organize fishery surveys to locate fishing grounds of neretic and oceanic squid and develop gear for catching them effectively;
- inventory of cephalopod resources to enable establishing a reference collection;
- cephalopod processing experiments to meet market demands, domestic or abroad.

THE HISTORICAL PROGRESS OF JAPANESE DISTANT-WATER FISHERIES FOR CEPHALOPODS

by

T. Sato and M. Hatanaka, For Seas Fisheries Research Laboratory Shemiza

(Summary only: the full report is being published by FAO in its Fishery Technical Paper series)

Japanese vessels catch squid in several distant-water areas. The most important is that off New Zealand (up to 50 000 t annually), followed by that in the northwest Atlantic 20 000-30 000 t annually). Smaller fisheries, of a few thousand tons, are carried out in the northwestern Arabian Sea, in the northwest Pacific, and in the southwest Atlantic, off Argentina. The catches off New Zealand are taken mostly by jigging, though trawl catches have recently increased. Catches per unit effort by bold gear show considerable variation between areas and in different years, the highest being observed in 1977/78.

REPUBLIC OF KOREA SQUID FISHERIES

by
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The kinds of squid distributed in the Korean waters are as follows:

(i) Omastrephidae - Todarodes pacificus

(ii) Loliginidae - Doryteuthis bleekeri, Doryteuthis kensaki and Loligo beka

(iii) Sepiidae - Sepia esculenta, Sepia subaculeata and Sepiella maindroni

Common squid, Todarodes pacificus, is one of the most important squid fisheries resources in the Republic of Korea. Most of them are being fished by coastal and off-shore angling fishery. According to the fishery statistics from 1975 to 1980 (Table 1) average catch ratio by angling fishery occupy about 86 percent of its total catch and the other fisheries are trawl (0.8%), Danish seine (3.8%), stow net (1.5%), gillnet (1.1%) and set net (5.5%), etc.

Most of them that are caught consume in domestic and some of them export to foreign countries. The marketing system changing in domestics is shown in Table 2. The export in 1980 was 4 250 thousand dollars and it exported 87% to Japan and 13% to Singapore, Hong Kong and the United States of America, etc.

At present, we are collecting the fishery statistics and size of individual data by sampling method in the major landing markets. Also, we are examining the biological information from the external and internal measurement and are carrying out the tagging experiment environmental survey on fishing grounds and fishing experiments by research vessel.

MALAYSIAN SQUID RESOURCES

by
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Little work has been carried out on the taxonomy of local species of squid occurring in our coastal waters. Taxonomic studies on the squid have only recently been initiated by the Fisheries Research Institute, Fisheries Division, Ministry of Agriculture to identify, compile and record the different species of squid that are found in Malaysian waters.

Five species identified are as follow:

(i) Loligo duvancelii

(ii) L. Tagoi

(iii) L. edulis

(iv) Doryteuthis singhalensis

(v) Sepioteuthis sp.

L. duvancelii is found in large quantities in catches of small trawlers (< 25-t to < 10-m depth) with small quantities of L. tagoi, L. edulis, Doryteuthis singhalensis and much less Sepioteuthis sp.

L. edulis and D. singhalensis are dominant in larger trawler catch fishing in deeper waters.

Table 1

Catch statistics of squid by fishery

(in t)

Fishery \ Year	1975	1976	1977	1978	1979	1980	Average	
							Catch	%
total	37 238	45 227	18 119	18 440	26 132	48 490	32 274	100.0
trawl	17	24	22	-	214	1 289	261	0.8
Danish seine	237	707	1 854	1 570	1 303	1 630	1 217	3.8
stow net	401	766	1 116	33	137	368	470	1.5
gillnet	203	584	58	43	144	1 166	366	1.1
angling	35 103	39 658	13 437	15 616	21 424	41 559	27 800	86.1
set net	1 064	3 017	1 380	826	2 139	2 218	1 774	5.5
others	213	471	252	352	771	260	386	1.2

Table 2

Marketing of fresh squid in major selected landing centre, by year

Year	Landings (A)	Consumed of landing area (B)	Shipped to area other than landing area (C)	Shipped to whole sale markets in consuming area (D)	Ratio		
					$\frac{B}{A}$	$\frac{C}{A}$	$\frac{D}{C}$
1975	28 814	20 374	8 440	3 954	71	29	43
1976	43 901	26 486	17 415	7 177	60	40	41
1977	25 967	15 150	10 817	6 353	58	42	59
1978	12 557	9 037	3 520	-	72	28	-
1979	17 938	11 887	6 051	-	66	34	-

No major directed fisheries for squid exist in the country except in one State on the East coast of Peninsular Malaysia where squid-jigging accounts for the bulk of squid landings in the state. However, the squid-jigging fishery is rather seasonal, with fishing activities conducted mainly between the months of April through July when squid are in season off the East coast.

Squid landings account for only around 2% of the total marine fish landings in the country in 1980. The bulk of the squid landing is attributed to trawlers, particularly on the West coast of Peninsular Malaysia where some 97% of the total squid landings come from trawlers. However, on the East coast of Peninsular Malaysia trawling and squid-jigging account for about 50% and 37% of the total squid landings respectively.

The squid that are landed are mainly sold in the local markets for local consumption. However, some of the squid landed are known to have been exported, mainly to Singapore (chilled) and some to Japan (frozen). Such exports are, however, very small in quantity.

As mentioned earlier, taxonomic studies of the local squid species have only been initiated under a recent research programme on squid. Among other data that will be collected under this programme are species composition of the squid catches, sizes of individuals, etc. However, landing statistics of squid have already been collected for quite some time under an ongoing national fisheries statistics collection programme carried out by the Fisheries Division, Ministry of Agriculture.

NEW ZEALAND SQUID FISHERY

by

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1. WHAT SQUID ARE KNOWN TO OCCUR IN NATIONAL WATERS?

At least 29 genera and 44 species of squid are found within New Zealand's 200-mile EEZ. Of these, only three species of two genera are of commercial importance. They are:

Nototodarus sloani - New Zealand arrow squid
Nototodarus sp. - New Zealand arrow squid
Sepioteuthis bilineata - Broad squid

Nototodarus sp. generally is found to the north of the Subtropical Convergence while *N. sloani* is found to the south. We do not know for certain which species we are dealing with to the north, but it may be *Nototodarus gouldi*, the Australian arrow squid. Dr Peter Smith (FRD, Wellington) is trying to obtain samples of *N. gouldi* from Australia for comparative electrophoretic studies with *N.* sp. from New Zealand.

The quantities of *Sepioteuthis bilineata* caught are relatively low, and this species is not of major commercial importance. There is no joint-venture (JV) or foreign-licensed fleet fishery for this species. Those taken are caught by the domestic fleet by trawl only.

A provisional list of species found within New Zealand's EEZ is appended (Table 1).

2. WHAT DIRECT FISHERIES FOR SQUID EXIST, AND HOW ARE THEY DEVELOPING?

2.1 *Nototodarus* spp.

Squid within New Zealand's waters are fished by squid-jigging boats and by trawlers.

2.2 Jigging

There is little if no squid jigged by New Zealand's domestic fleet. There is very large effort in this fishery by foreign-licensed vessels and by joint-venture operations between New Zealand and foreign fishing companies.

The foreign-licensed jig fleet is at present almost exclusively Japanese (98 vessels in 1981/82) with a limited input from Korea (4 vessels).

The foreign involvement in the JV jig fleet (78 vessels licensed in 1981/82) is primarily Japanese, with some Korean and Taiwanese involvement.

2.3 Trawlers

Trawlers target fish for squid in the region to the south of New Zealand, usually well below 47°S. The best grounds are on the Auckland shelf, between 49°30'S and 51°10'S; and 166°E and 168°E. Jig boats do not fish in this region because of the poor weather and high seas common in the area.

The trawlers involved are primarily foreign-licensed vessels (USSR, Japan, Korea) and JV vessels (USSR, Korea, Japan and Poland). Rarely do New Zealand-owned and operated vessels fish on the Auckland shelf because of weather conditions in relation to vessel size. Quotas are set for each fleet and for different areas round New Zealand (see Table 2).

Foreign-licensed vessels do not land their catch in New Zealand. The catches are either returned to their home port (e.g., Japan) or else part or all of the squid catch is sold in the international market before the vessels return home (e.g., USSR).

The JV catch is often landed in New Zealand where some processing may take place. JV squid are sold as a product of New Zealand in overseas markets.

3. TO WHAT EXTENT ARE SQUID CAUGHT IN OTHER FISHERIES?

A quota is set annually on the amount of squid trawlers are allowed to catch in all areas within the New Zealand region. With the exception of the Southern Islands, Area E (Auckland shelf) and part of Area F (just north of the Auckland shelf) this quota is provided to cover the incidental catch of squid in conjunction with other mixed species trawl fisheries. Because of the limitations placed on foreign and JV trawlers with regard to areas in which they are permitted to fish, the actual by-catch of squid is usually low.

4. WHERE ARE THE SQUID THAT ARE CAUGHT SOLD, AND HOW ARE MARKETS CHANGING?

Most squid caught by the JV is being sold on the Japanese and Taiwanese markets (last season, 1980-81, 4 381 t went to Japan and 6 551 t went to Taiwan). There are small markets for New Zealand processed squid (tubes) in Kuwait, Saudi Arabia, Greece, USA and Australia. There is a small domestic market which is adequately filled by the domestic trawl fleet.

When the demand for squid in Japan was high, jigged squid commanded a higher price than trawled squid. The jigged squid were usually sold as fresh frozen, while the trawled squid were processed into such things as, for example, dried squid. The market for New Zealand squid in Japan is down, and most all squid from New Zealand is being processed. Consequently the difference in value between trawled squid and jigged squid on the Japanese market has narrowed. Export prices (CIF) in 1980/81 for jigged squid averaged $ NZ 940 (range 480-1 210) to Japan, and $ 1 503 to Taiwan. Trawl-squid prices in the same season were $ 1 150 (Japan), $ 1 184 (Korea) and $ 576 (USSR).

5. WHAT DATA ARE BEING COLLECTED?

All foreign-licensed and JV vessels are required to fill in fishing logbooks supplied by New Zealand. Samples of the books issued to trawlers and jig boats are appended.

FRD personnel working on squid collect data on the reproductive status, sex ratio, length frequencies and weight of Nototodarus spp. (refer to the appended research outline). Specimens of all squid species collected are now returned to the laboratory for identification and are being catalogued in a FRD squid collection.

6. ARE ATTEMPTS BEING MADE TO ASSESS NATIONAL SQUID RESOURCES; WHAT METHODS ARE BEING USED, AND WHAT PROBLEMS ARE BEING MET?

Attempts are made to assess stock sizes of Nototodarus spp. These estimates are often based on commercial catch data. We have some data taken by random stratified surveys to use for stock assessment, but these data have been collected from the waters south of 47°S. Stock-size estimates are based on the areas expansion method.

It is very difficult to assess squid stocks for a number of reasons. They are highly mobile, and we do not know for certain how many different stocks we are dealing with. They are seasonal in abundance and appear to be short-lived, surviving for about 1-1.5 years. We do not know how these squid react to a trawl, nor do we have any estimate with which we can be confident, of escapement from the trawl.

Table 1

SQUID REPORTED FROM NEW ZEALAND WATERS (EEZ)

Architeuthidae	
Architeuthis kirki	
Batoteuthidae	
Bathyteuthidae	
Branchioteuthidae	
Branchioteuthis sp.	*B. picta*
Chiroteuthidae	
Chiroteuthis sp.	*C. verangi*
Cranchiidae	
Megalocranchia pardus	*T. belone*
M. maxima	*T. richardsoni*
M. richardsoni	*Sandalops melancholicus*
Pyrgopsis pacifica	*Galiteuthis armata*
Teuthowenia megalops impennis	*Bathothauma lyromma*
*T. antarctica**	*Fusocranchia pellucida*
Leachia cyclura	*Liocranchia reinhardti*
L. eschscholtzii	*Cranchia scabra*
Taonius pavo	
Ctenopterygidae	
Ctenopteryx sp.	
Cycloteuthidae	
Cycloteuthis sp.	
Enoploteuthidae	
Abraliopsis sp.	*Pterygiotheuthis* sp.
*A. neozealandica**	*P. giardi**

Gonatidae

Gonatus antarticus

Histioteuthidae

Histioteuthis sp.
H. atlantica
H. miranda
H. cookiana
H. macrohista
H. eltaninae
*Calliteuthis cookiana**

Lepidoteuthidae

Loliginidae

Sepioteuthis bilineata

Lycoteuthidae

Mastigoteuthidae

Mastigoteuthis sp.
M. flemmea

Neoteuthidae

Octopoteuthidae

Ommastrephidae

Nototodarus sp.
N. sloani
Todarodes filippovae
Ommastrephes bartramii

Onychoteuthidae

Onychoteuthis banksi
Moroteuthis ingens

Spirulidae

Spirula spirula

Species marked * were taken from Clarke (1966). All others are specimens held in the National Museum, Wellington, New Zealand.

Clarke, M.R., 1966 A review of the systematics and ecology of oceanic squids. Advances in Marine Biology, 4:91-300

Table 2

SQUID QUOTAS FOR THE TRAWL FISHERY IN THE 1981/82 SEASON (in t)

Trawl Fleet

	Korea	Japan	USSR	JV	Total
Southern Islands - Area E (Auckland shelf)	1 300	5 000	9 500	14 200	30 000
Area F (off the south of the Southern Islands)	100	2 000		1 800	3 900
Remainder Area E (Bounty - Antipodes Islands)	100	1 500	2 000	3 500	7 100
All other Areas	100	1 400		7 500	9 000
Total	1 600	9 900	11 500	27 000	50 000

THE PHILLIPINES

Note: The squid fishery in the Philippines has been recently reviewed by A.M. Hernando and E.E.C. Flores (The Philippines Squid Fishery: A review; Marine Fisheries Review, January 1981, pp. 13-20), and their paper was made available to the SCORRAD meeting. Squid are caught in many coastal areas, but not in the offshore waters. Statistics on catch by area and fishery gear, and information on the fishery methods are presented in the report.

SQUID FISHERIES OF THAILAND

by

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1. INTRODUCTION

Squid is one of the most important economic resources, and the demand is increasing year by year. The combined exports of squid and cuttlefish is second only to the export of shrimp among fishery products. The export value of squid and cuttlefish in 1971 was only US$ 4.8 million and increased to US$ 98 million in 1979.

In the early days, squid fishery was in small scale along the coastal areas. The fishing gear used were hook, scoop net, trap and cast net with lamps or torches to attract the squid. Since 1961, trawl fisheries have developed and squid are now mostly taken by both otter-board trawl and pair trawl.

At present, squid fisheries by light attraction are very popular along the East coast of the Gulf of Thailand (from Trat to Cholburi provinces) and the West coast of the Gulf of Thailand (from Phetburi to Surat-Tani provinces). Power supply sources are from the generators of 3-12 kW. Majority of squid fishing boats are converted from otter-board trawlers and some push net fishing boats.

2. SPECIES COMPOSITION

The species of squid found in the Gulf of Thailand and the Andeman Sea are as follows:

Loligo duvaucelii d'Orbigny
Loligo formosana Sasaki
Loligo tagoi Sasaki
Sepioteuthis lessoniana Lesson

The distribution and abundance of squid had been studied by the Research Vessels PRAMONG 4 and PRAMONG 5. The research was conducted monthly at night in 9 areas in the Gulf of Thailand (Figure 1). Squid are found in all areas at the depth of about 50 m. Details of the apparent abundance (kg per hour fishery by the survey vessels) are presented in Table 1.

3. FISHERIES

3.1 Fishing gear

Squid are caught by several fishing gear such as otter-board trawl, pair trawl, bamboo stake trap, beam trawl, push net, squid cast net, hook, squid hook, luring purse seine and set bag net. Otter-board trawl and pair trawl are the major fishing gear for large-scale squid fishery, while squid cast net, hook and squid hook are for small-scale squid fishery. The percentage of catch from otter-board trawl, pair trawl and squid cast net are 48.96%, 44.65% and 3.39% respectively (average from 1971-79).

Attraction of squid with the aid of lights such as torches or lamps have long-time been employed. Gradually, electric lamps are substituted. Since 1979, the techniques and gear used have greatly developed and became popular among fishermen. In addition, trawl operator are converting their vessels into squid fishing boats due to the losses in trawling operation.

Squid fishing by the use of lights are in 2 types:

(i) Squid cast net

The vessels range from 8 to 11 m in length. The generator employed is 3-5 kW. However, cast net is not effective enough to catch a large school of squid. Thus the number is on the decreasing trend.

(ii) Squid lift net

The vessels are 11-14 m in length. The generator employed is 5-10 kW. Catch by this type of fishing gear is greater than squid cast net.

(iii) Modified squid cast net or giant cast net

The vessels are at least 10 m in length. The generator employed is 8-12 kW. This fishing gear is very effective and has gained popularity among the fishermen. The number of vessels is rapidly increasing. The main advantage of this gear is that it can capture squid deeper than the other types.

Based on the survey in 1981, 120 vessels used squid cast net, squid lift net or modified squid cast net, and made a little less than 98 000 sets.

3.2 Fishing areas and seasons

Fishing areas of squid are in the Gulf of Thailand and the Andaman Sea. Squid fishing areas by otter-board trawl and pair trawl in the Gulf of Thailand are shown in Figure 2 and 3 respectively. The most productive areas are area G for otter-board trawl (Figure 2) and area C for pair trawl (Figure 3). Both types of trawlers can operate all year round except during the monsoon.

Fishing areas of squid fishing by the use of lights are along the East and West coast of the Gulf of Thailand. The period of fishing is 20 days per month, starting from four days after full moon until eight days after the next new moon.

4. CATCH

The annual catches of squid and cuttlefish fluctuated from 1971-79 and peaked in 1977 and 1978 (see Table 4). Catch in both the Gulf of Thailand and the Andaman Sea show the same trends as the total catch. The squid production of Thailand has fluctuated from 37 191 MT in 1975, to 36 163 MT in 1976, to 52 255 MT in 1977, to 52 067 MT in 1978 and to 42 283 MT in 1979.

Most of the catch were from otter-board trawl and pair trawl. The catch composition of squid in percent by commercial sampling of otter-board trawlers and pair trawlers in the Gulf of Thailand are shown in Table 2a and b. Loligo formosana is the dominant species caught by otter-board trawlers, pair trawlers and also the research vessels. Catch per hour and percentage surveyed by the research vessels in the Gulf of Thailand, 1977-80, varied from 2.00 kg/hr in 1977, to 1.60 kg/hr in 1978, to 1.64 kg/hr in 1979, and to 1.71 kg/hr in 1980. Catch per hour of L. duvaucelii, L. formosana and Sepioteuthis lessoniana decreased from 1977 to 1980, but the catch per hour of L. tagoi increased.

5. BIOLOGICAL INFORMATION

The biology of squid have been studied by the Invertebrate Fisheries Unit, Marine Fisheries Division. The summary on squid-spawning season, fecundity, size of individuals, mean weight, mean length, sex ratio, stomach contents and length-weight relationship are shown in Table 3.

6. RESOURCE ASSESSMENT

The direct methods of resource assessment which employed a simple mathematical model based on the relation between the fishing effort and its associated catch rates, namely, Schaefer's and Fox's models, are used to estimate the maximum sustainable yield (MSY) of the squid resources in Thai waters. Both models were tested for the best fit to the available data and the best fitted model was then selected for assessment.

In determining the total fishing effort in the squid fisheries in the Gulf of Thailand and also the Andaman Sea, the average catch per hour of squid by the research vessels PRAMONG 2 and PRAMONG 9 during 1971-79 was used as the standard index of abundance. Prior to 1971 the catches of squid by the research vessels increased presumably as a reaction to heavy exploitation of the demersal fish. It is believed that, in using the production model, the period since 1971 can be taken as typical of a heavy fished system, but the conclusions regarding MSY and the optimum level of effort for squid might have to be changed if the overall pattern of fisheries changes. The results yielded the estimated potential of the squid stocks in the Gulf of Thailand to be about 41 965 t with its corresponding optimum fishing effort of 6.29 million hours. For the Adaman Sea stocks, the estimated MSY was calculated to be 5 834 t with its corresponding optimum fishing effort of 1.2 million hours.

The estimated MSY for the squid fisheries in the Gulf of Thailand was probably reached in 1977. For the Andaman Sea stocks, it probably reached in 1973. Therefore, with the increasing trend of fishing effort afterward, the catch had declined to lower level than the estimated MSY.

7. UTILIZATION

Squid are utilized mainly for export and domestic consumption. The data on utilization, export and import of squid (cuttlefish is included) are shown in Table 4. The fresh consumption was 36 759 t in 1973 and decreased to 21 875 t in 1979. The export production of squid and cuttlefish increased yearly. In 1979, the export production was 43 295 t worth US$ 98 million. Major markets for the export of squid and cuttlefish production are Japan, Italy, France and Spain.

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Table 1

ABUNDANCE OF SQUID FORM THE SURVEY OF RESEARCH VESSELS IN THE GULF OF THAILAND, 1979

Abundance (kg/hr) by areas

Species \ Areas	I	II	III	IV	V	VI	VII	VIII	IX	I-IX
L. duvaucelii	0.263	0.426	0.271	0.617	1.219	0.819	0.516	0.375	0.561	0.580
L. formosana	0.640	0.969	1.011	1.477	0.872	0.064	0.395	1.580	1.475	0.953
L. tagoi	0.009	0.015	0.012	0.012	0.063	0.069	0.044	0.061	0.108	0.047
Sep. lessoniana	0.136	0.185	0.239	0.128	0.052	0.029	0.025	0.103	0.128	0.110

Abundance (kg/hr) by month

Species \ Months	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan - Dec
L. duvaucelii	0.570	1.193	0.951	0.239	0.256	0.616	0.588	0.567	0.555	0.30	0.269	0.528	0.580
L. formosana	0.990	1.536	1.262	1.106	1.063	0.865	0.832	0.614	0.796	0.625	0.773	0.521	0.953
L. tagoi	0.076	0.068	0.053	0.021	0.016	0.046	0.041	0.035	0.066	0.049	0.053	0.024	0.047
Sep. lessoniana	0.117	0.095	0.173	0.218	0.210	0.106	0.118	0.057	0.042	0.051	0.040	0.049	0.110

Abundance (kg/hr) depth and season

Species	depth (m)				Season	
	10-19	20-29	30-39	40	Southwest monsoon (May-July)	Northeast monsoon (Nov.-April)
L. duvaucelii	0.228	0.511	0.701	0.903	0.478	0.681
L. formosana	0.238	1.089	1.037	1.241	0.792	1.114
L. tagoi	0.032	0.052	0.043	0.054	0.042	0.051
Sep. lessoniana	0.124	0.124	0.109	0.062	0.094	0.126

Table 2a

Catch composition of squid in percent by commercial sampling otter-board trawlers in the Gulf of Thailand, 1979

Areas	Loligo duvaucelii	Loligo formosana	Loligo tagoi	Sepioteuthis lessoniana	Sepia spp.	Octopus spp.
A	12.30	17.68	0.59	7.03	40.43	21.97
B	6.99	19.66	0.19	8.70	17.77	46.69
C	-	-	very	rare	40.9	59.09
D	4.17	3.05	0.19	1.25	45.21	46.14
E	13.56	11.21	0.25	16.41	35.22	23.34
F	17.94	13.40	0.06	5.16	44.68	18.75
G	11.02	28.19	0.70	14.20	30.07	15.82
A-G	10.34	14.14	0.32	8.68	37.32	29.20

Table 2b

Catch composition of squid in percent by commercial sampling of pair trawlers in the Gulf of Thailand, 1979

Areas	Loligo duvaucelii	Loligo formosana	Loligo tagoi	Sepioteuthis lessoniana	Sepia spp.	Octopus spp.
A	13.59	31.51	0.35	6.49	33.24	14.82
B	17.36	38.61	0.69	28.36	11.56	3.42
C	17.96	51.15	0.27	4.50	20.94	5.18
A-C	16.15	40.16	0.42	12.16	22.83	8.28

Table 3

Biological data of squid

Species	1 Spawning season	2 Fecundity	3 Size of individuals (cm)	4 Mean weight (gm)	5 Mean length (cm)	6 Sex ratio :	7 Stomach contents	8 Lenght-Weight relationship	References
L. duvaucelii	Feb.-May	1 000-4 000	3.0-23.9	37.20	8.7-9.6	1:1.28	Cephalopods Fishes	n = 3604 $W = 0.00902812L^{1.80608313}$	1.Ratana-anan, T. 1976-79
			2.0-17.9				Crustaceans	n = 4652 $W = 0.00260176L^{2.09662902}$	2.Ratana-anan, T. 1978
									3.Kittirorachat, K 1979
L. formosana	Feb.-May Aug.-Nov.	800-7 000	3.0-51.9	120.77	15.0-16.6	1:1.48	Cephalopods Fish	n = 1541 $W = 0.001414925L^{1.97486740}$	4.,5.Sinanuwong K. K 1979
			2.0-26.9				Crustaceans	n = 2294 $W = 0.00165386L^{2.18393351}$	6.Ratana-anan, T. 1978
Sep. lessoniana	being studied	480-1 020	5.0-25.9	137.55	10.4-13.5	1:2.17	Crustaceans Fishes	n = 186 $W = 0.00271399L^{2.21831488}$	7.Ratana-anan, 1976-79 T.
			4.0-22.9				Cephalopods	n = 511 $W = 0.0088016L^{2.45404798}$	8.Ratana-anan, T. 1978

Table 4

Utilization of squid and cuttlefish in Thailand, 1973-79 (metric tons)

Year	Total catch	Fresh consumption	For export frozen	Dried and salted	Fish sauce	Fish canned	Others	Import	Export
1973	81 409	36 759	21 966	19 919	-	-	2 765	243	15 749
1974	64 629	39 403	2 426	21 751	-	-	1 049	119	17 524
1975	64 825	34 393	5 254	22 909	-	-	2 269	212	19 271
1976	63 952	37 040	5 686	18 463	646	-	2 117	202	24 376
1977	93 679	27 962	38 600	27 045	-	72	-	196	29 070
1978	93 654	9 154	54 500	27 000	-	3 000	-	104	38 311
1979	80 142	21 875	39 359	18 888	-	20	-	103	43 295

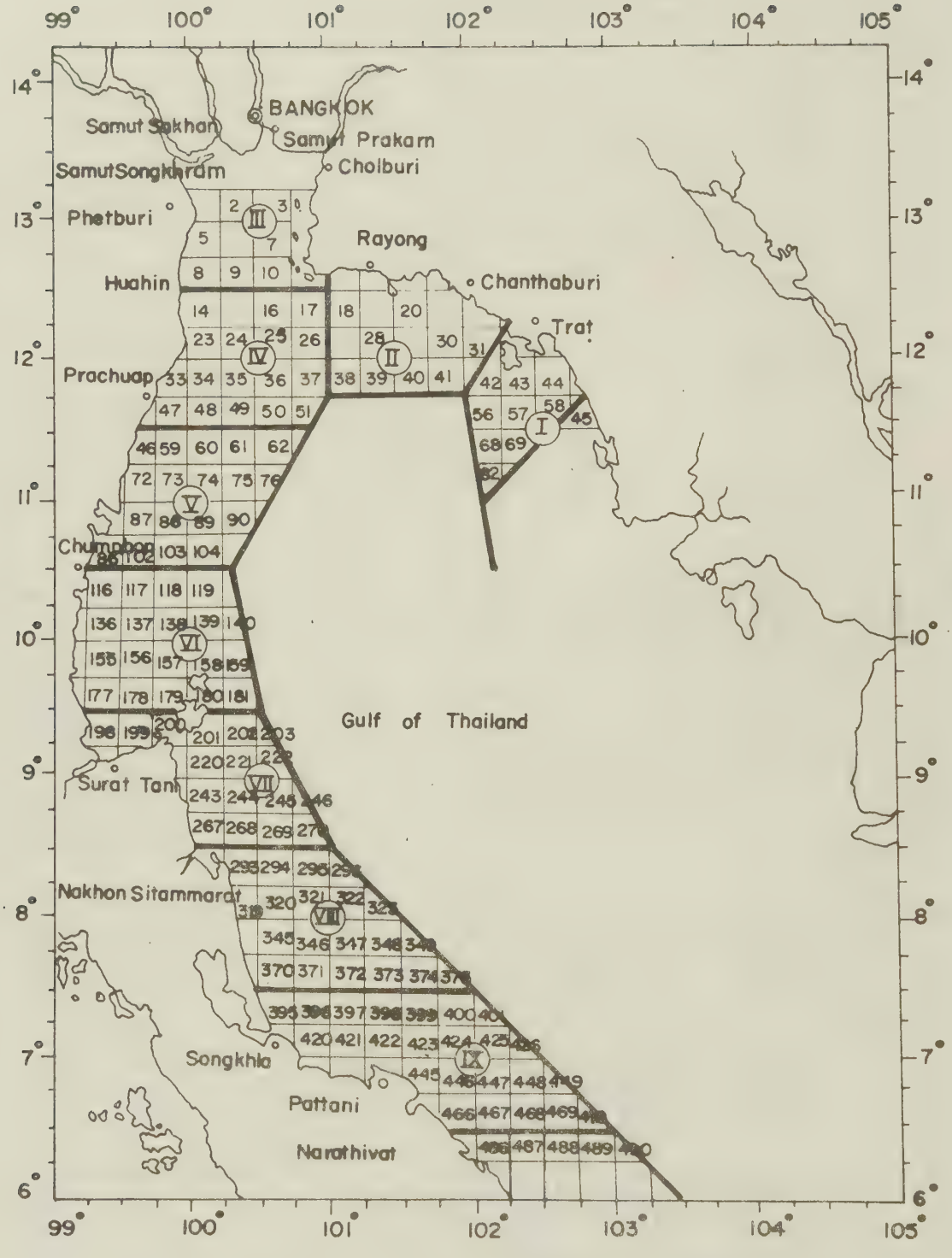

Fig 1. Areas and stations for shrimp survey by Research Vessels in the Gulf of Thailand.

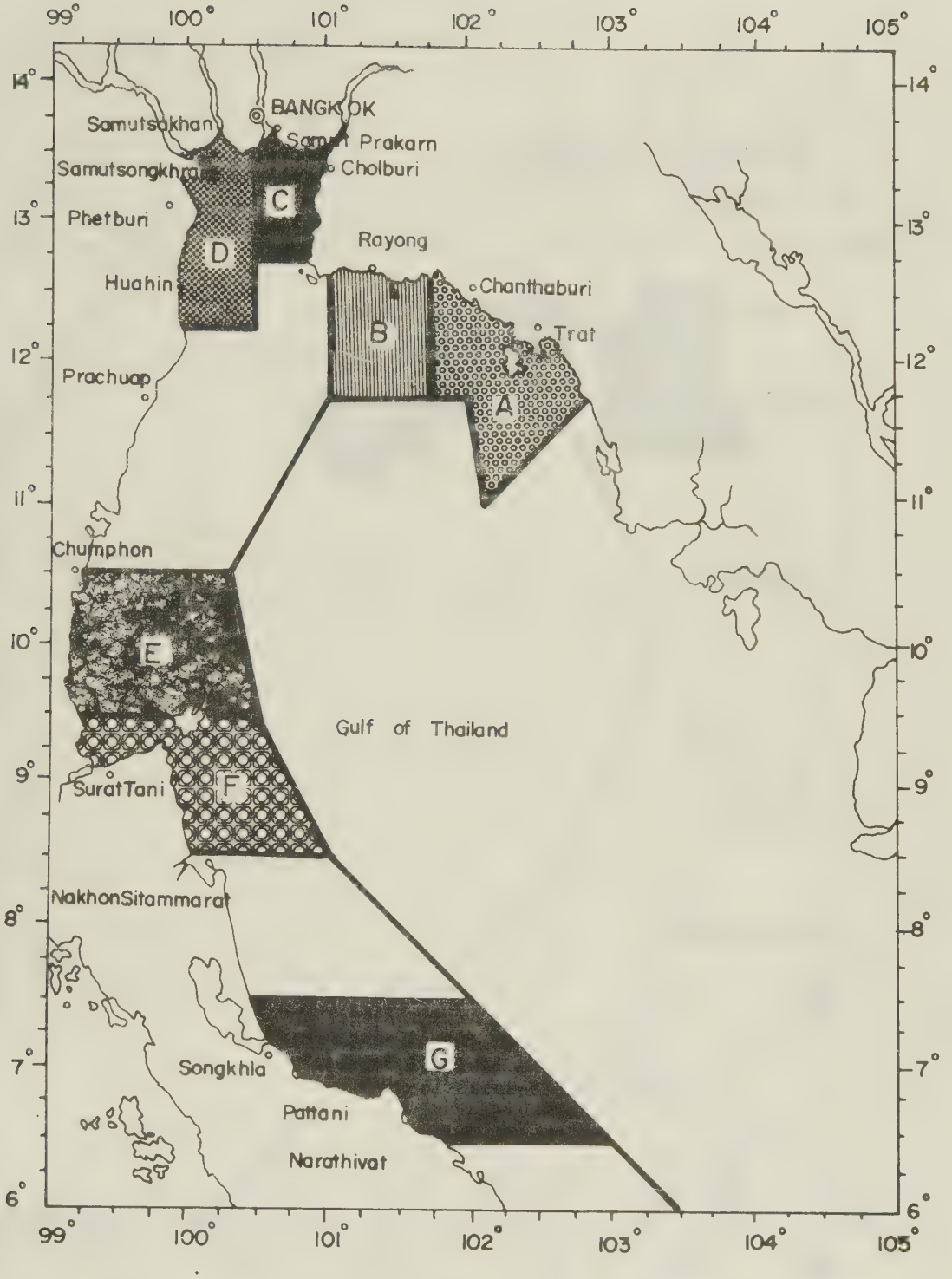

Fig 2. Fishing areas of squid by otter-board trawlers 1979.

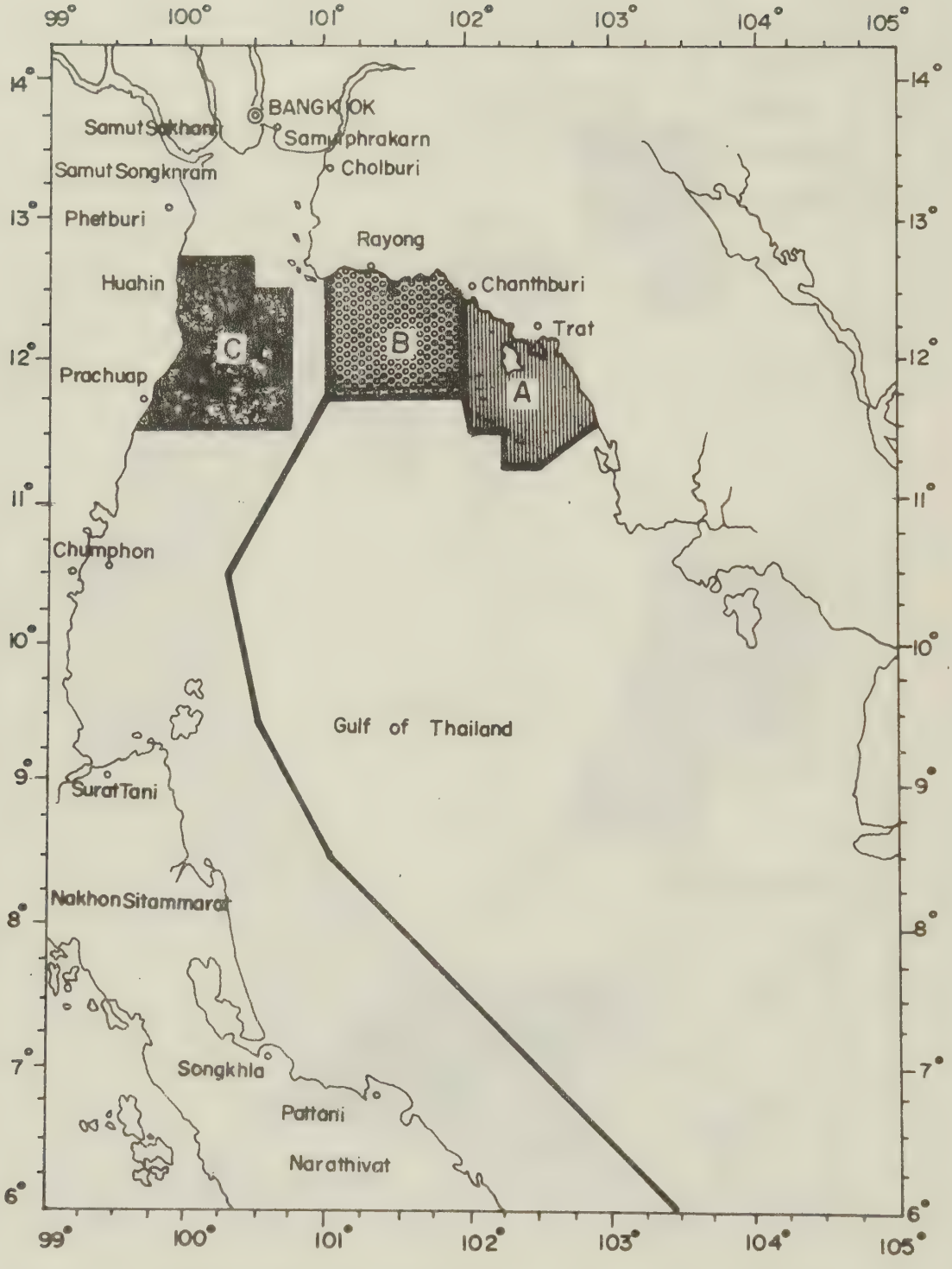

Fig 3. Fishing areas of squid by pair trawlers, 1979.

THE STATUS OF THE SQUID FISHERIES IN THE UNITED STATES OF AMERICA

by

Walter M. Matsumoto
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(Summary only)

Squid catches in the United States are small, though showing an upward trend. The biggest catches are taken on the Pacific coast, mostly off California, when catches reached 17 000 t in 1978. Catches on the east coast, mostly in New England and the Mid-Atlantic states have been around 1 000-2 000 t but reaches 6 000 t. Local consumption is small, and much of the New England catch was used as bait. Currently a high proportion is exported, either canned or frozen, but consideration is being given to promoting local markets.

THE JAPANESE MARKET REVIEW AND OUTLOOK FOR SQUID AND CUTTLEFISH

by

M. Hotta
FAO, Rome

(Summary only)

This paper reviewed the species currently being sold on the Japanese market, the types of products involved, and the main sources of supply, including imports. It is now being revised and expanded, and will be published repeatedly by FAO.